FIG. 1

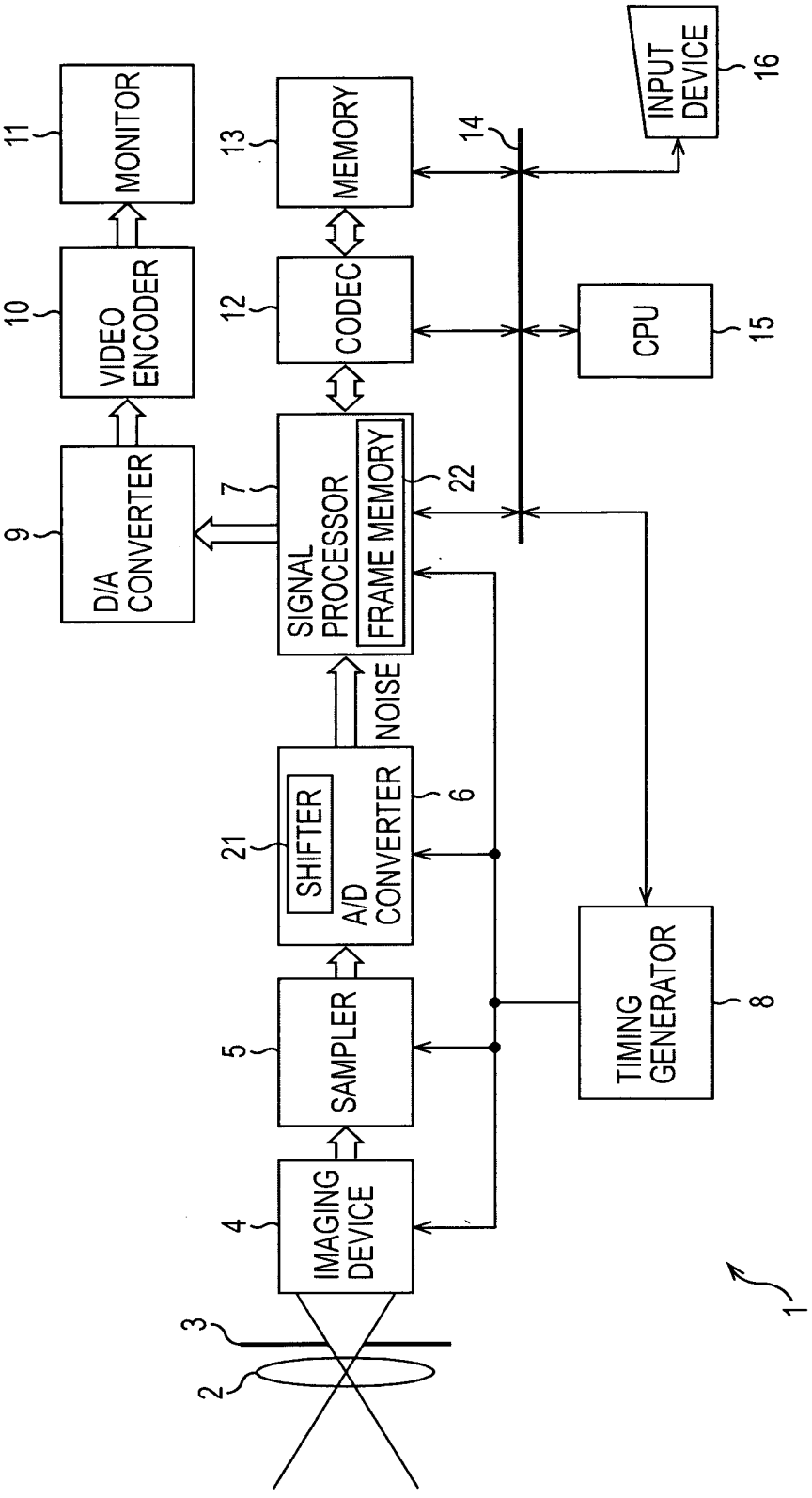
1
2
3
IMAGING DEVICE
4
SAMPLER
5
A/D CONVERTER
SHIFTER
21
6
NOISE
SIGNAL PROCESSOR
FRAME MEMORY
7
22
TIMING GENERATOR
8
D/A CONVERTER
9
VIDEO ENCODER
10
MONITOR
11
CODEC
12
MEMORY
13
14
CPU
15
INPUT DEVICE
16

FIG. 2

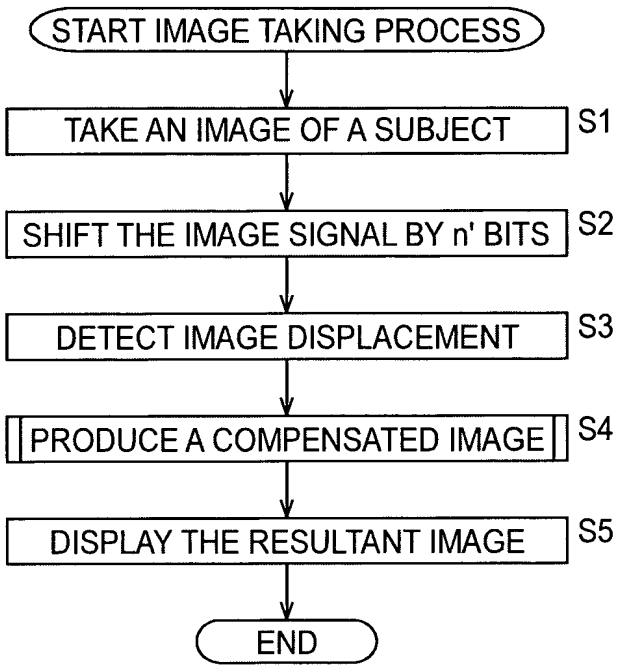
START IMAGE TAKING PROCESS
TAKE AN IMAGE OF A SUBJECT
S1
SHIFT THE IMAGE SIGNAL BY n' BITS
S2
DETECT IMAGE DISPLACEMENT
S3
PRODUCE A COMPENSATED IMAGE
S4
DISPLAY THE RESULTANT IMAGE
S5
END

FIG. 3

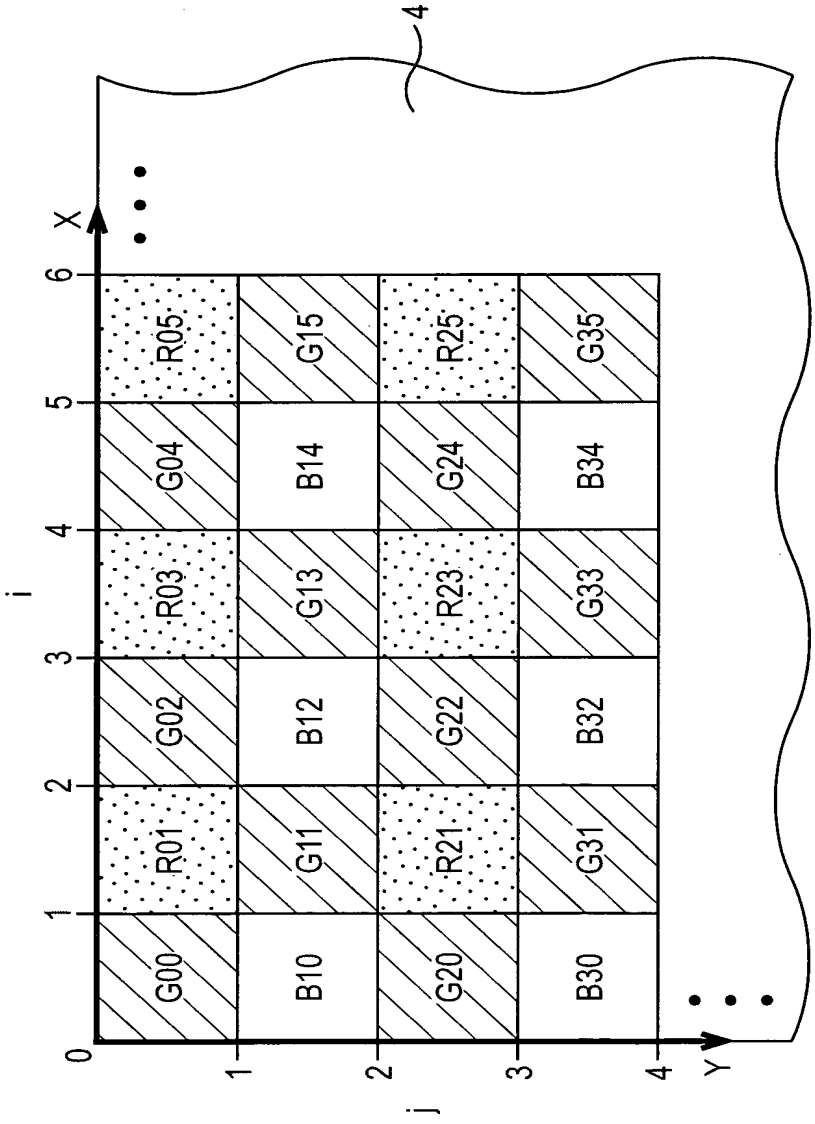
4
X
Y
i
j
0
1
2
3
4
5
6
G00
R01
G02
R03
G04
R05
B10
G11
B12
G13
B14
G15
G20
R21
G22
R23
G24
R25
B30
G31
B32
G33
B34
G35

FIG. 4

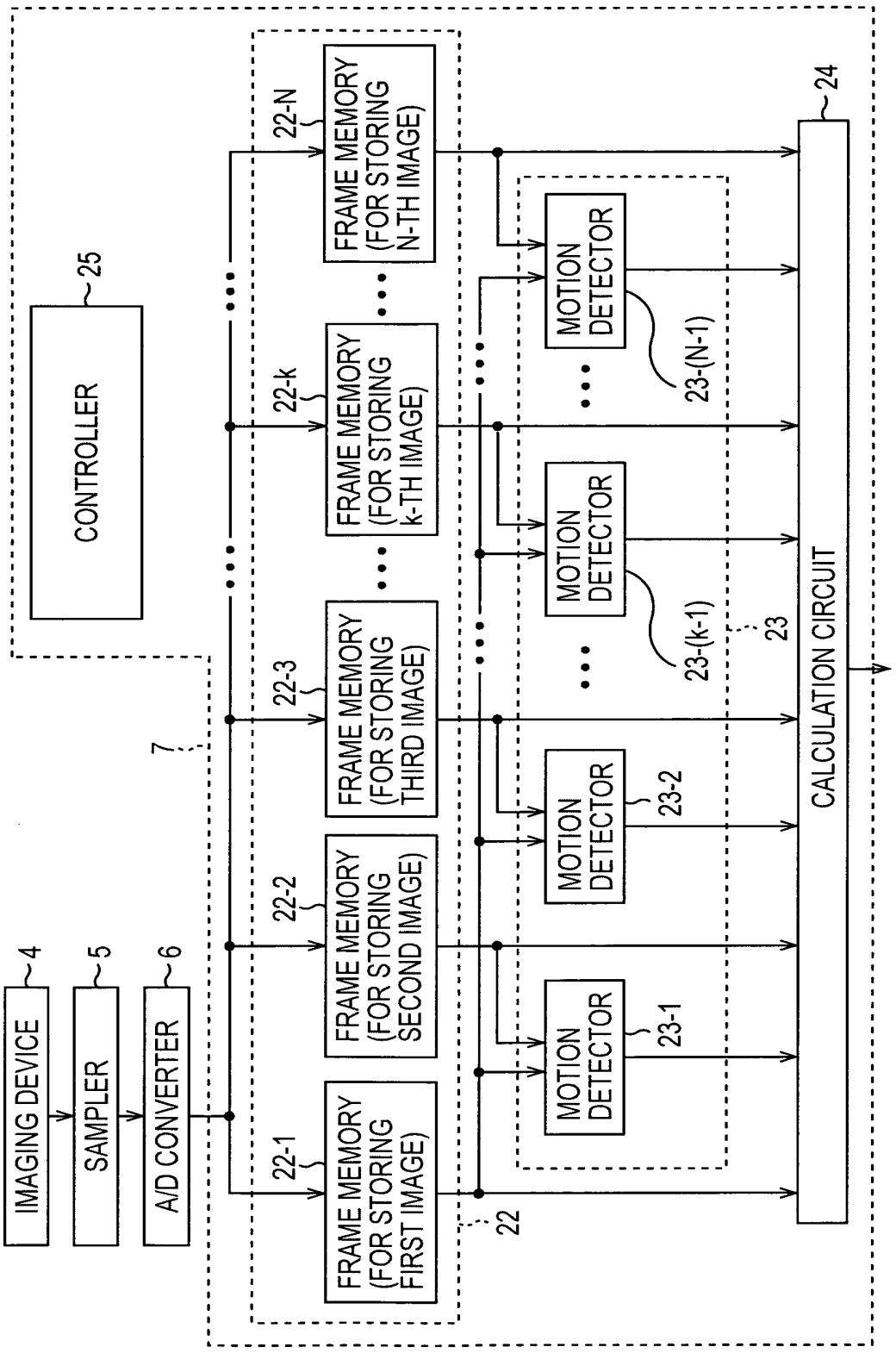
IMAGING DEVICE
4
SAMPLER
5
A/D CONVERTER
6
7
CONTROLLER
25
FRAME MEMORY (FOR STORING FIRST IMAGE)
22-1
FRAME MEMORY (FOR STORING SECOND IMAGE)
22-2
FRAME MEMORY (FOR STORING THIRD IMAGE)
22-3
FRAME MEMORY (FOR STORING k-TH IMAGE)
22-k
FRAME MEMORY (FOR STORING N-TH IMAGE)
22-N
22
MOTION DETECTOR
23-1
MOTION DETECTOR
23-2
MOTION DETECTOR
23-(k-1)
MOTION DETECTOR
23-(N-1)
23
CALCULATION CIRCUIT
24

FIG. 5

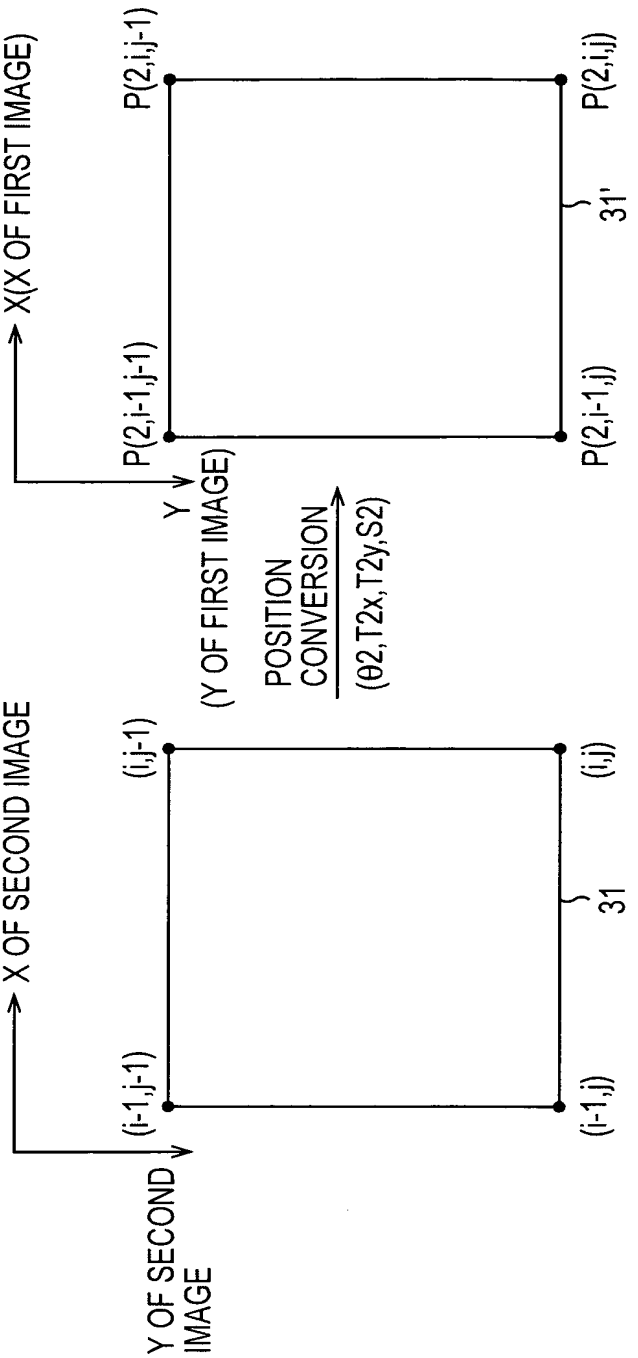
X(X OF FIRST IMAGE)
Y
(Y OF FIRST IMAGE)
P(2,i-1,j-1)
P(2,i,j-1)
P(2,i-1,j)
P(2,i,j)
31'
POSITION CONVERSION
(θ2,T2x,T2y,S2)
X OF SECOND IMAGE
Y OF SECOND IMAGE
(i-1,j-1)
(i,j-1)
(i-1,j)
(i,j)
31

FIG. 6

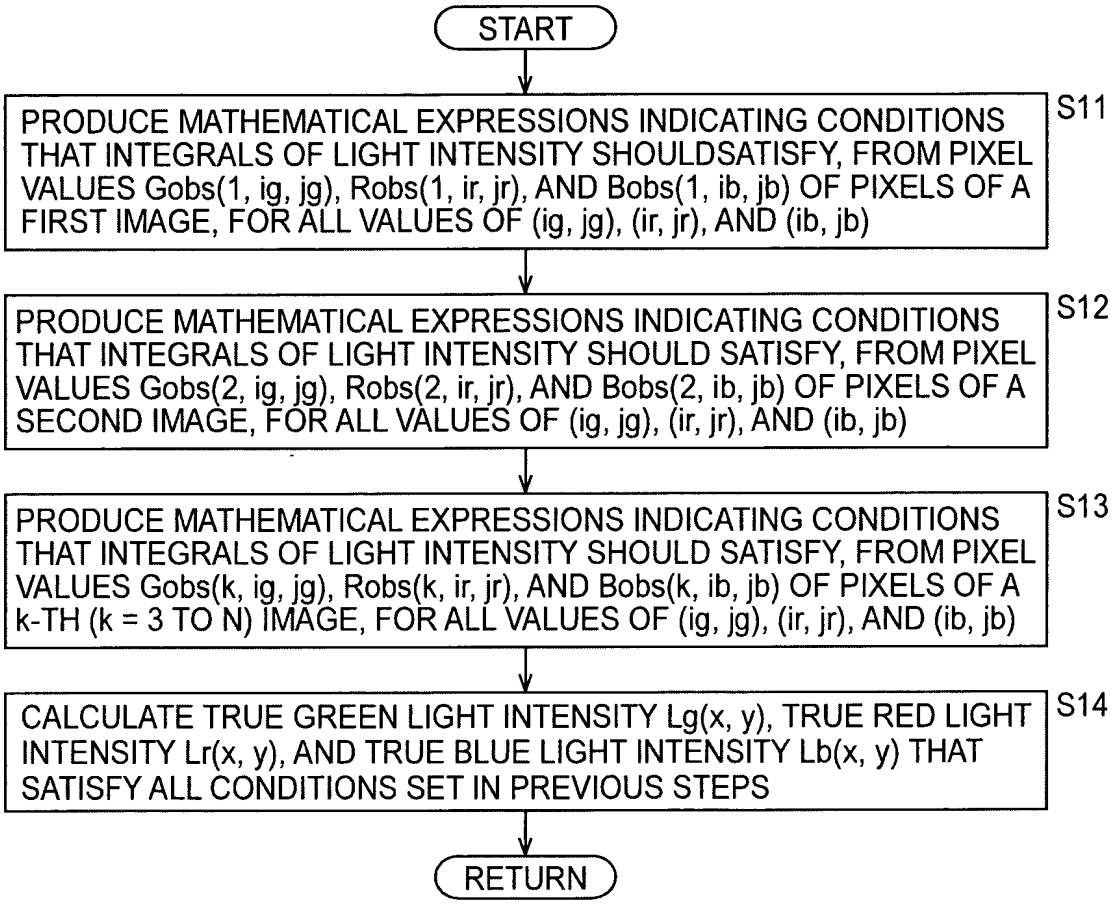
START
PRODUCE MATHEMATICAL EXPRESSIONS INDICATING CONDITIONS THAT INTEGRALS OF LIGHT INTENSITY SHOULDSATISFY, FROM PIXEL VALUES Gobs(1, ig, jg), Robs(1, ir, jr), AND Bobs(1, ib, jb) OF PIXELS OF A FIRST IMAGE, FOR ALL VALUES OF (ig, jg), (ir, jr), AND (ib, jb)
S11
PRODUCE MATHEMATICAL EXPRESSIONS INDICATING CONDITIONS THAT INTEGRALS OF LIGHT INTENSITY SHOULD SATISFY, FROM PIXEL VALUES Gobs(2, ig, jg), Robs(2, ir, jr), AND Bobs(2, ib, jb) OF PIXELS OF A SECOND IMAGE, FOR ALL VALUES OF (ig, jg), (ir, jr), AND (ib, jb)
S12
PRODUCE MATHEMATICAL EXPRESSIONS INDICATING CONDITIONS THAT INTEGRALS OF LIGHT INTENSITY SHOULD SATISFY, FROM PIXEL VALUES Gobs(k, ig, jg), Robs(k, ir, jr), AND Bobs(k, ib, jb) OF PIXELS OF A k-TH (k = 3 TO N) IMAGE, FOR ALL VALUES OF (ig, jg), (ir, jr), AND (ib, jb)
S13
CALCULATE TRUE GREEN LIGHT INTENSITY Lg(x, y), TRUE RED LIGHT INTENSITY Lr(x, y), AND TRUE BLUE LIGHT INTENSITY Lb(x, y) THAT SATISFY ALL CONDITIONS SET IN PREVIOUS STEPS
S14
RETURN

FIG. 7

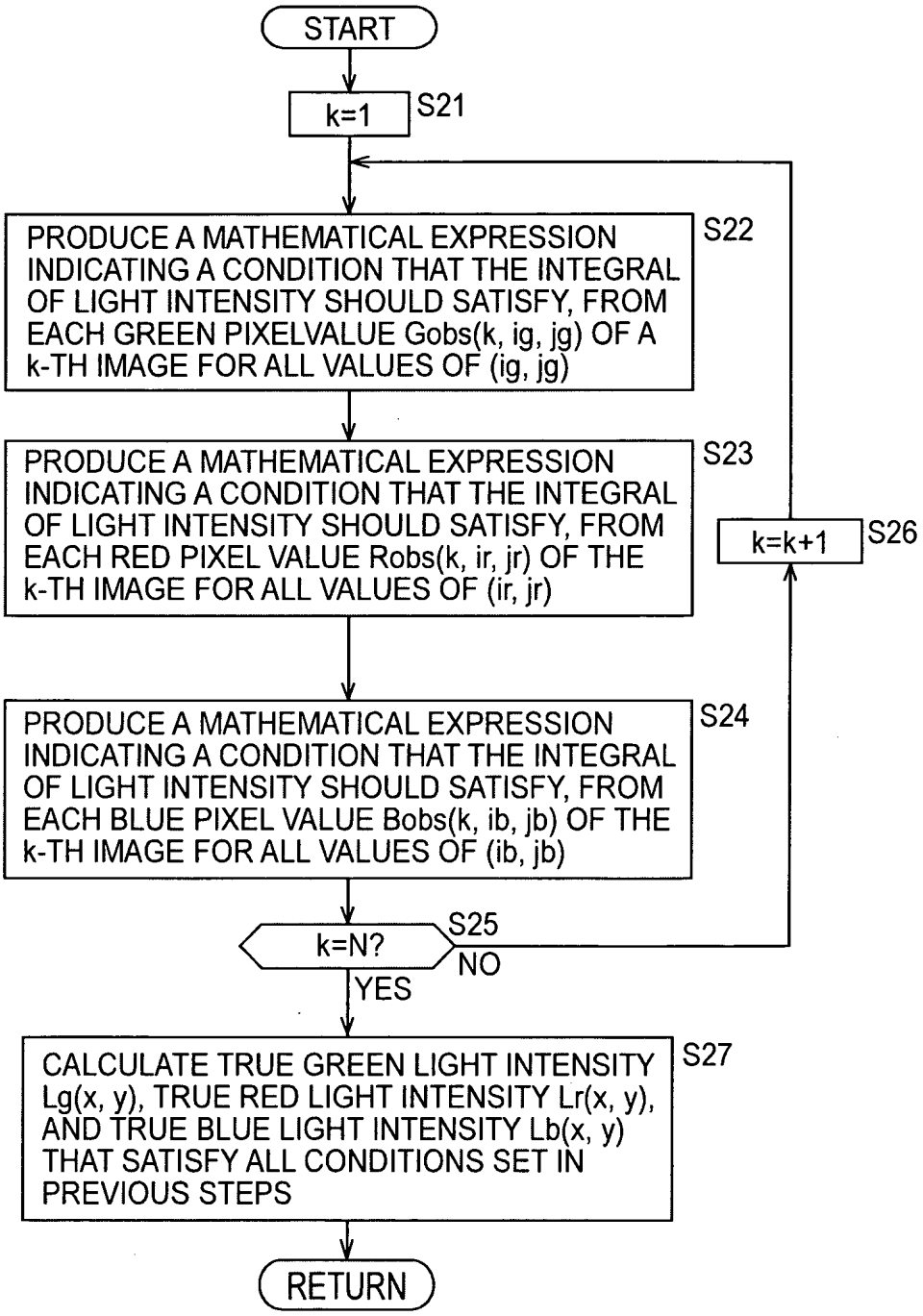
START
k=1
S21
PRODUCE A MATHEMATICAL EXPRESSION INDICATING A CONDITION THAT THE INTEGRAL OF LIGHT INTENSITY SHOULD SATISFY, FROM EACH GREEN PIXELVALUE Gobs(k, ig, jg) OF A k-TH IMAGE FOR ALL VALUES OF (ig, jg)
S22
PRODUCE A MATHEMATICAL EXPRESSION INDICATING A CONDITION THAT THE INTEGRAL OF LIGHT INTENSITY SHOULD SATISFY, FROM EACH RED PIXEL VALUE Robs(k, ir, jr) OF THE k-TH IMAGE FOR ALL VALUES OF (ir, jr)
S23
k=k+1
S26
PRODUCE A MATHEMATICAL EXPRESSION INDICATING A CONDITION THAT THE INTEGRAL OF LIGHT INTENSITY SHOULD SATISFY, FROM EACH BLUE PIXEL VALUE Bobs(k, ib, jb) OF THE k-TH IMAGE FOR ALL VALUES OF (ib, jb)
S24
k=N?
S25
NO
YES
CALCULATE TRUE GREEN LIGHT INTENSITY Lg(x, y), TRUE RED LIGHT INTENSITY Lr(x, y), AND TRUE BLUE LIGHT INTENSITY Lb(x, y) THAT SATISFY ALL CONDITIONS SET IN PREVIOUS STEPS
S27
RETURN

FIG. 8

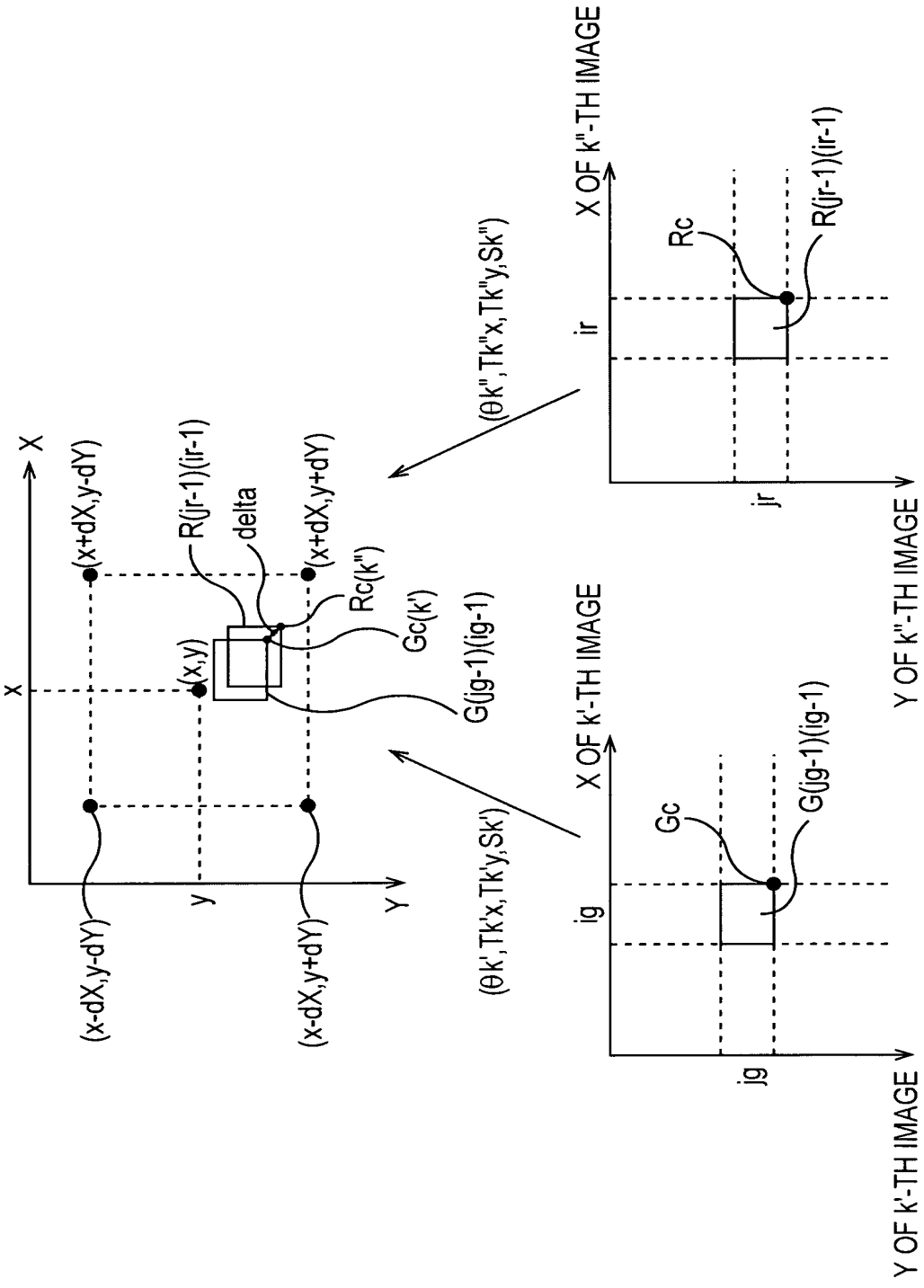
X
Y
x
y
(x,y)
(x+dX,y-dY)
(x-dX,y-dY)
(x+dX,y+dY)
(x-dX,y+dY)
R(jr-1)(ir-1)
delta
Rc(k")
Gc(k')
G(jg-1)(ig-1)
(θk",Tk"x,Tk"y,Sk")
(θk',Tk'x,Tk'y,Sk')
X OF k"-TH IMAGE
Y OF k"-TH IMAGE
X OF k'-TH IMAGE
Y OF k'-TH IMAGE
ir
jr
ig
jg
Rc
Gc
R(jr-1)(ir-1)
G(jg-1)(ig-1)

FIG. 9

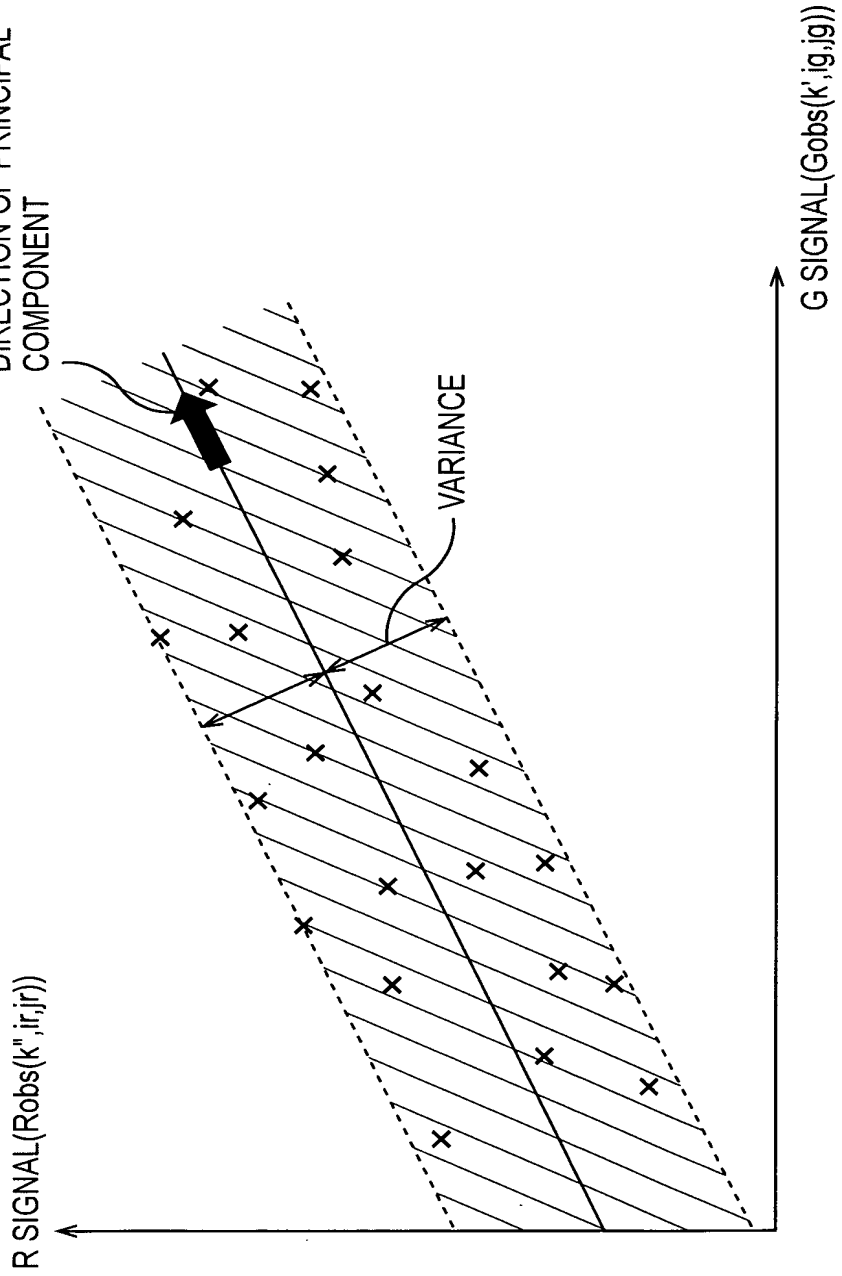
DIRECTION OF PRINCIPAL COMPONENT
VARIANCE
G SIGNAL(Gobs(k',ig,jg))
R SIGNAL(Robs(k'',ir,jr))

FIG. 10

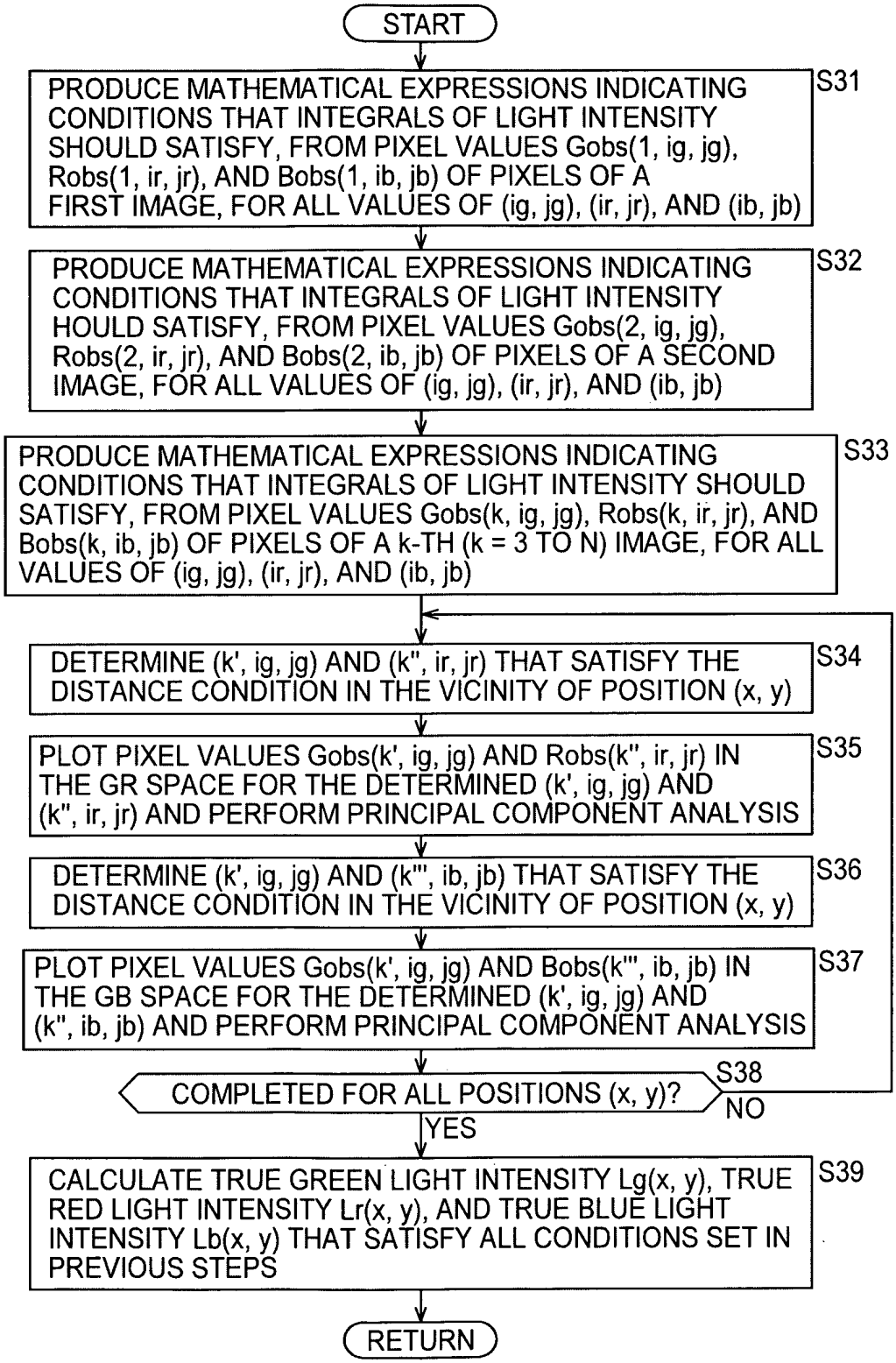
START
PRODUCE MATHEMATICAL EXPRESSIONS INDICATING CONDITIONS THAT INTEGRALS OF LIGHT INTENSITY SHOULD SATISFY, FROM PIXEL VALUES Gobs(1, ig, jg), Robs(1, ir, jr), AND Bobs(1, ib, jb) OF PIXELS OF A FIRST IMAGE, FOR ALL VALUES OF (ig, jg), (ir, jr), AND (ib, jb)
S31
PRODUCE MATHEMATICAL EXPRESSIONS INDICATING CONDITIONS THAT INTEGRALS OF LIGHT INTENSITY HOULD SATISFY, FROM PIXEL VALUES Gobs(2, ig, jg), Robs(2, ir, jr), AND Bobs(2, ib, jb) OF PIXELS OF A SECOND IMAGE, FOR ALL VALUES OF (ig, jg), (ir, jr), AND (ib, jb)
S32
PRODUCE MATHEMATICAL EXPRESSIONS INDICATING CONDITIONS THAT INTEGRALS OF LIGHT INTENSITY SHOULD SATISFY, FROM PIXEL VALUES Gobs(k, ig, jg), Robs(k, ir, jr), AND Bobs(k, ib, jb) OF PIXELS OF A k-TH (k = 3 TO N) IMAGE, FOR ALL VALUES OF (ig, jg), (ir, jr), AND (ib, jb)
S33
DETERMINE (k', ig, jg) AND (k", ir, jr) THAT SATISFY THE DISTANCE CONDITION IN THE VICINITY OF POSITION (x, y)
S34
PLOT PIXEL VALUES Gobs(k', ig, jg) AND Robs(k", ir, jr) IN THE GR SPACE FOR THE DETERMINED (k', ig, jg) AND (k", ir, jr) AND PERFORM PRINCIPAL COMPONENT ANALYSIS
S35
DETERMINE (k', ig, jg) AND (k"', ib, jb) THAT SATISFY THE DISTANCE CONDITION IN THE VICINITY OF POSITION (x, y)
S36
PLOT PIXEL VALUES Gobs(k', ig, jg) AND Bobs(k"', ib, jb) IN THE GB SPACE FOR THE DETERMINED (k', ig, jg) AND (k", ib, jb) AND PERFORM PRINCIPAL COMPONENT ANALYSIS
S37
COMPLETED FOR ALL POSITIONS (x, y)?
S38
NO
YES
CALCULATE TRUE GREEN LIGHT INTENSITY Lg(x, y), TRUE RED LIGHT INTENSITY Lr(x, y), AND TRUE BLUE LIGHT INTENSITY Lb(x, y) THAT SATISFY ALL CONDITIONS SET IN PREVIOUS STEPS
S39
RETURN

FIG. 11

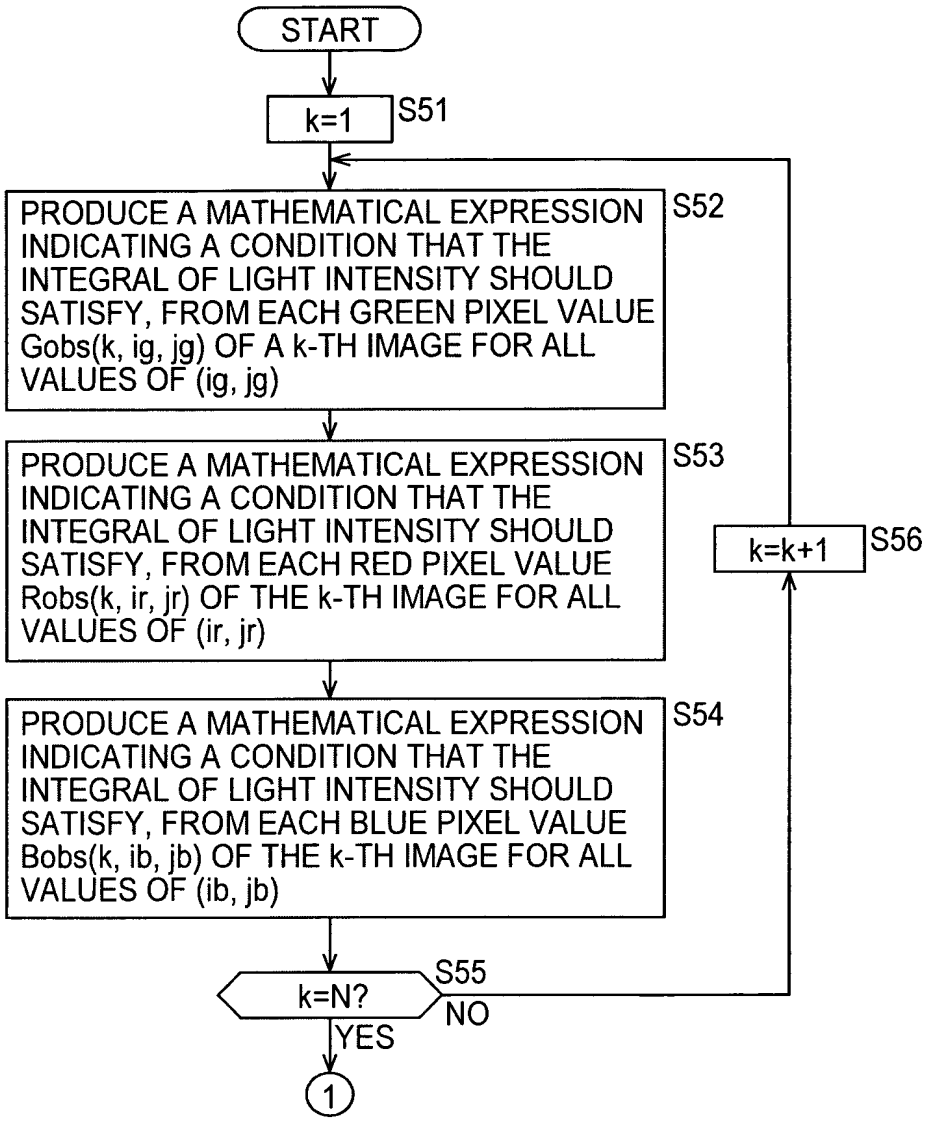
START
k=1
S51
PRODUCE A MATHEMATICAL EXPRESSION INDICATING A CONDITION THAT THE INTEGRAL OF LIGHT INTENSITY SHOULD SATISFY, FROM EACH GREEN PIXEL VALUE Gobs(k, ig, jg) OF A k-TH IMAGE FOR ALL VALUES OF (ig, jg)
S52
PRODUCE A MATHEMATICAL EXPRESSION INDICATING A CONDITION THAT THE INTEGRAL OF LIGHT INTENSITY SHOULD SATISFY, FROM EACH RED PIXEL VALUE Robs(k, ir, jr) OF THE k-TH IMAGE FOR ALL VALUES OF (ir, jr)
S53
PRODUCE A MATHEMATICAL EXPRESSION INDICATING A CONDITION THAT THE INTEGRAL OF LIGHT INTENSITY SHOULD SATISFY, FROM EACH BLUE PIXEL VALUE Bobs(k, ib, jb) OF THE k-TH IMAGE FOR ALL VALUES OF (ib, jb)
S54
k=N?
S55
NO
YES
k=k+1
S56
1

FIG. 12

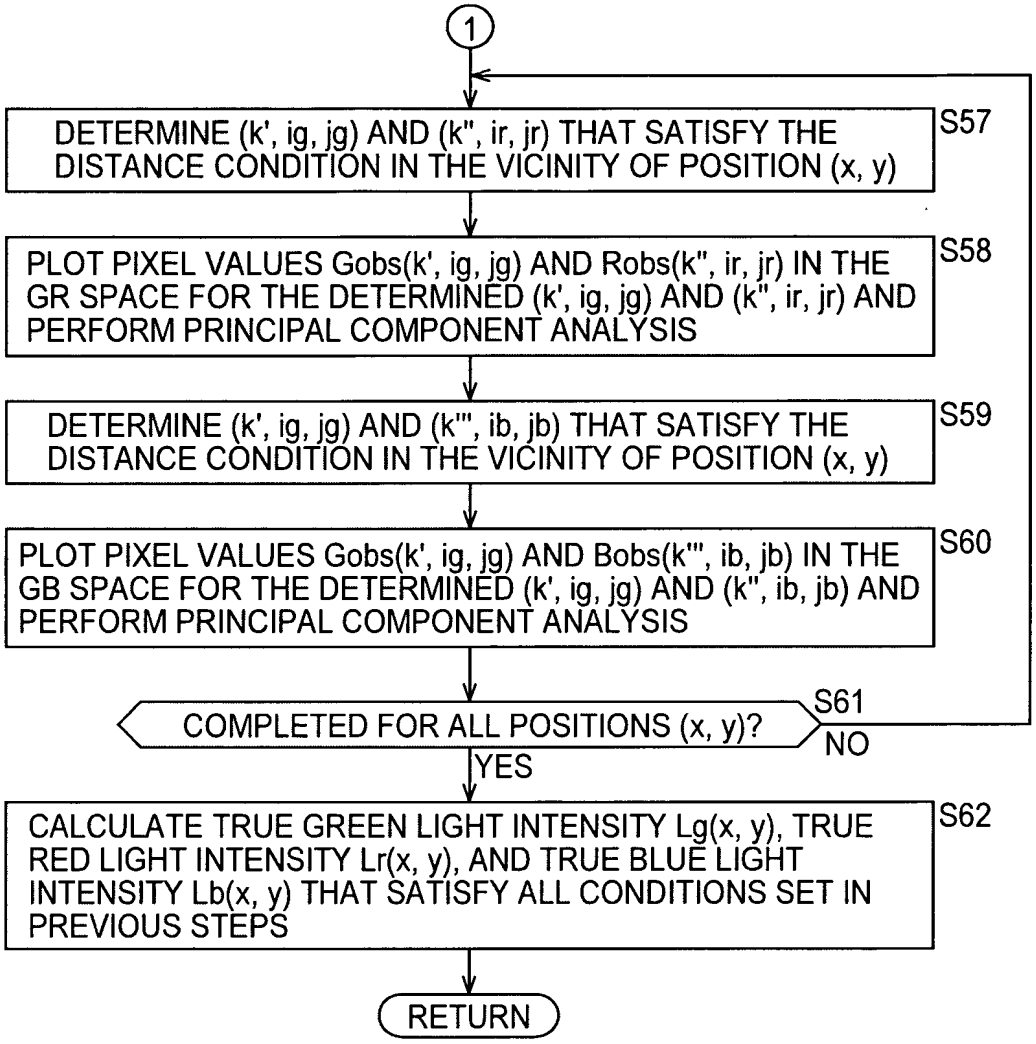
1
DETERMINE (k', ig, jg) AND (k", ir, jr) THAT SATISFY THE DISTANCE CONDITION IN THE VICINITY OF POSITION (x, y)
S57
PLOT PIXEL VALUES Gobs(k', ig, jg) AND Robs(k", ir, jr) IN THE GR SPACE FOR THE DETERMINED (k', ig, jg) AND (k", ir, jr) AND PERFORM PRINCIPAL COMPONENT ANALYSIS
S58
DETERMINE (k', ig, jg) AND (k"', ib, jb) THAT SATISFY THE DISTANCE CONDITION IN THE VICINITY OF POSITION (x, y)
S59
PLOT PIXEL VALUES Gobs(k', ig, jg) AND Bobs(k"', ib, jb) IN THE GB SPACE FOR THE DETERMINED (k', ig, jg) AND (k", ib, jb) AND PERFORM PRINCIPAL COMPONENT ANALYSIS
S60
COMPLETED FOR ALL POSITIONS (x, y)?
S61
NO
YES
CALCULATE TRUE GREEN LIGHT INTENSITY Lg(x, y), TRUE RED LIGHT INTENSITY Lr(x, y), AND TRUE BLUE LIGHT INTENSITY Lb(x, y) THAT SATISFY ALL CONDITIONS SET IN PREVIOUS STEPS
S62
RETURN

FIG. 13

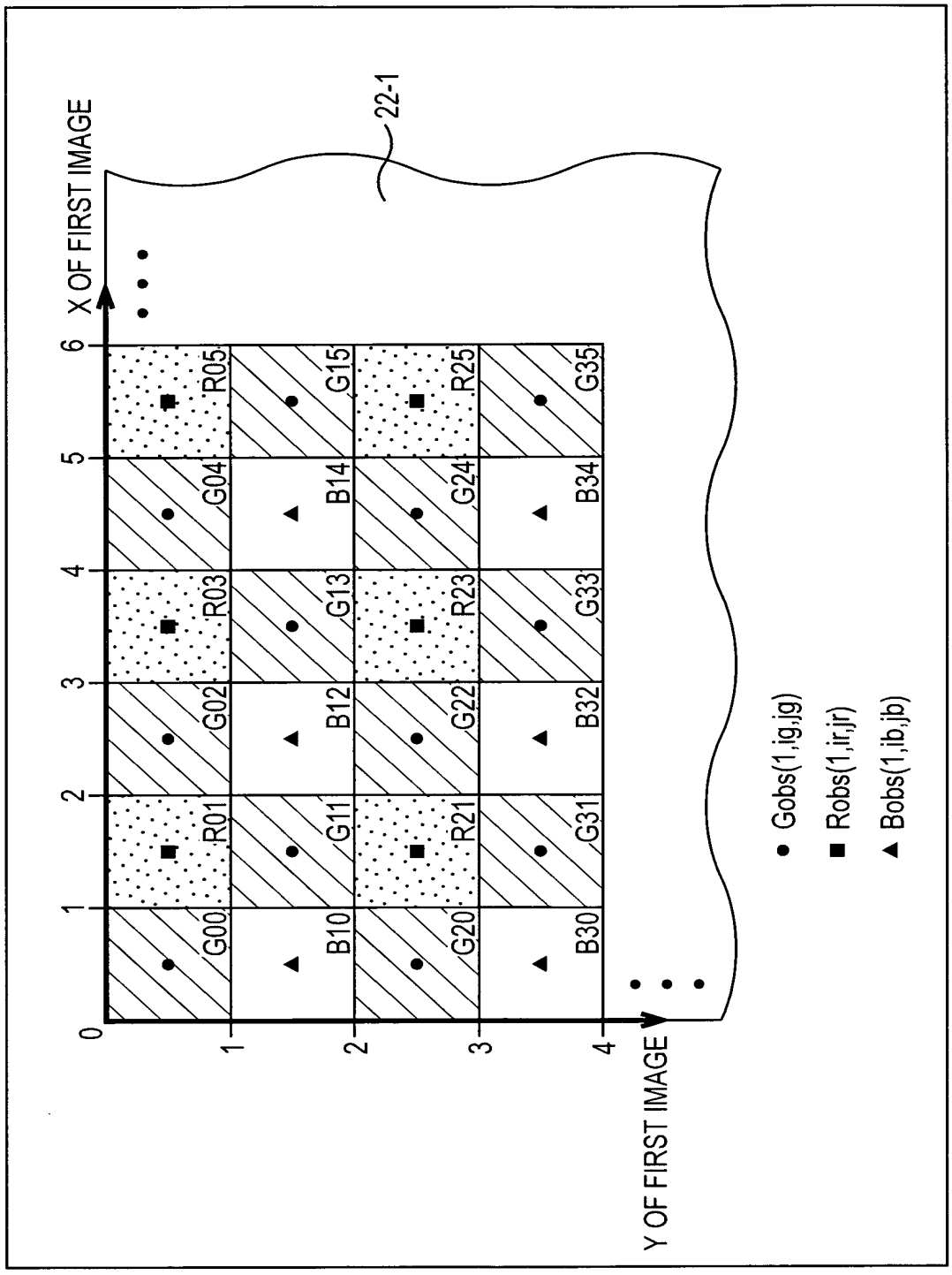
22-1
X OF FIRST IMAGE
Y OF FIRST IMAGE
0
1
2
3
4
5
6
G00
R01
G02
R03
G04
R05
B10
G11
B12
G13
B14
G15
G20
R21
G22
R23
G24
R25
B30
G31
B32
G33
B34
G35
● Gobs(1,ig,jg)
■ Robs(1,ir,jr)
▲ Bobs(1,ib,jb)

FIG. 14

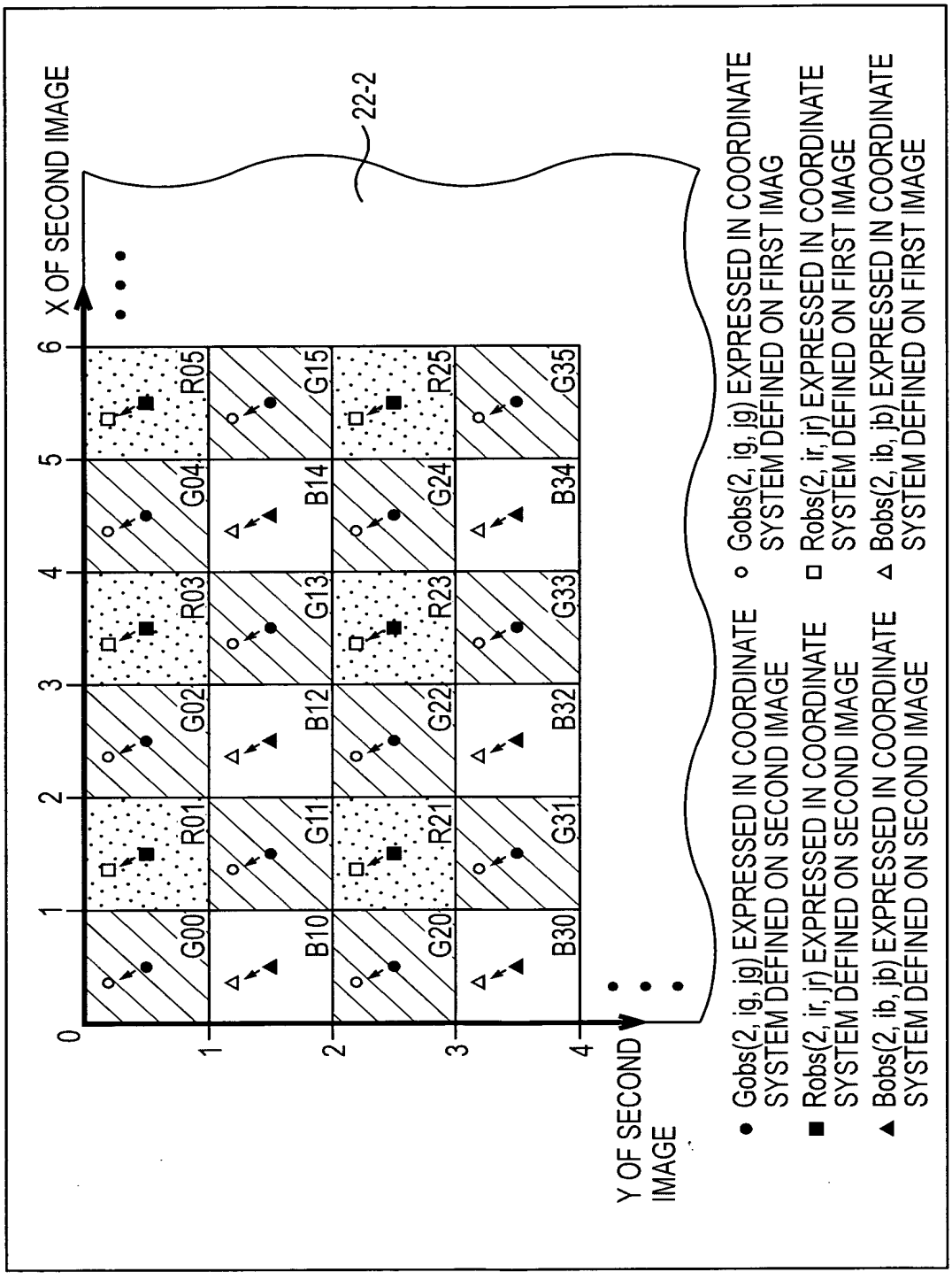
X OF SECOND IMAGE
Y OF SECOND IMAGE
22-2
0
1
2
3
4
5
6
G00
R01
G02
R03
G04
R05
B10
G11
B12
G13
B14
G15
G20
R21
G22
R23
G24
R25
B30
G31
B32
G33
B34
G35
• Gobs(2, ig, jg) EXPRESSED IN COORDINATE SYSTEM DEFINED ON SECOND IMAGE
■ Robs(2, ir, jr) EXPRESSED IN COORDINATE SYSTEM DEFINED ON SECOND IMAGE
▲ Bobs(2, ib, jb) EXPRESSED IN COORDINATE SYSTEM DEFINED ON SECOND IMAGE
○ Gobs(2, ig, jg) EXPRESSED IN COORDINATE SYSTEM DEFINED ON FIRST IMAG
□ Robs(2, ir, jr) EXPRESSED IN COORDINATE SYSTEM DEFINED ON FIRST IMAGE
△ Bobs(2, ib, jb) EXPRESSED IN COORDINATE SYSTEM DEFINED ON FIRST IMAGE

FIG. 15

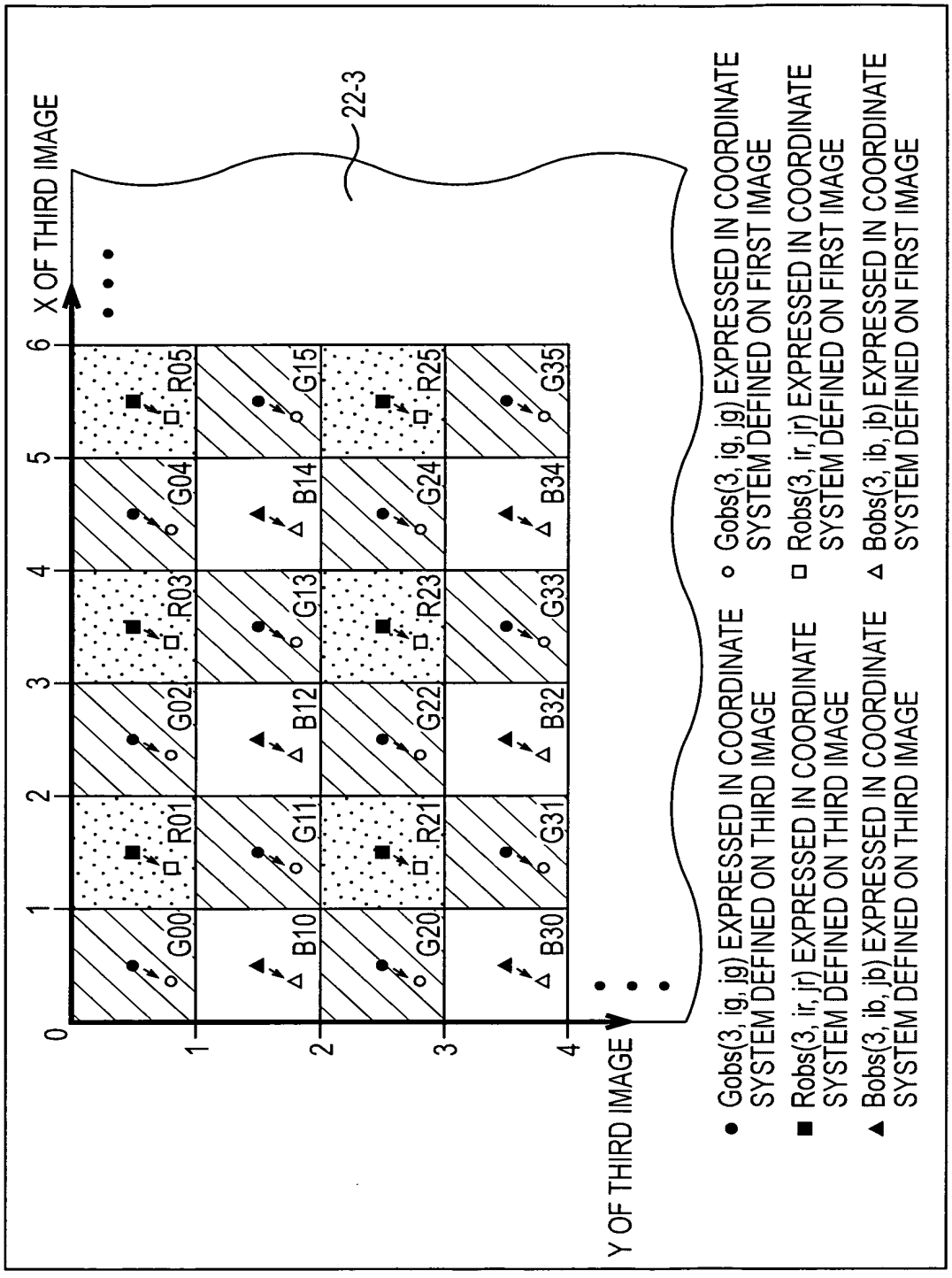
X OF THIRD IMAGE
Y OF THIRD IMAGE
0
1
2
3
4
5
6
G00
R01
G02
R03
G04
R05
B10
G11
B12
G13
B14
G15
G20
R21
G22
R23
G24
R25
B30
G31
B32
G33
B34
G35
22-3
• Gobs(3, ig, jg) EXPRESSED IN COORDINATE SYSTEM DEFINED ON THIRD IMAGE
■ Robs(3, ir, jr) EXPRESSED IN COORDINATE SYSTEM DEFINED ON THIRD IMAGE
▲ Bobs(3, ib, jb) EXPRESSED IN COORDINATE SYSTEM DEFINED ON THIRD IMAGE
○ Gobs(3, ig, jg) EXPRESSED IN COORDINATE SYSTEM DEFINED ON FIRST IMAGE
□ Robs(3, ir, jr) EXPRESSED IN COORDINATE SYSTEM DEFINED ON FIRST IMAGE
△ Bobs(3, ib, jb) EXPRESSED IN COORDINATE SYSTEM DEFINED ON FIRST IMAGE

FIG. 16

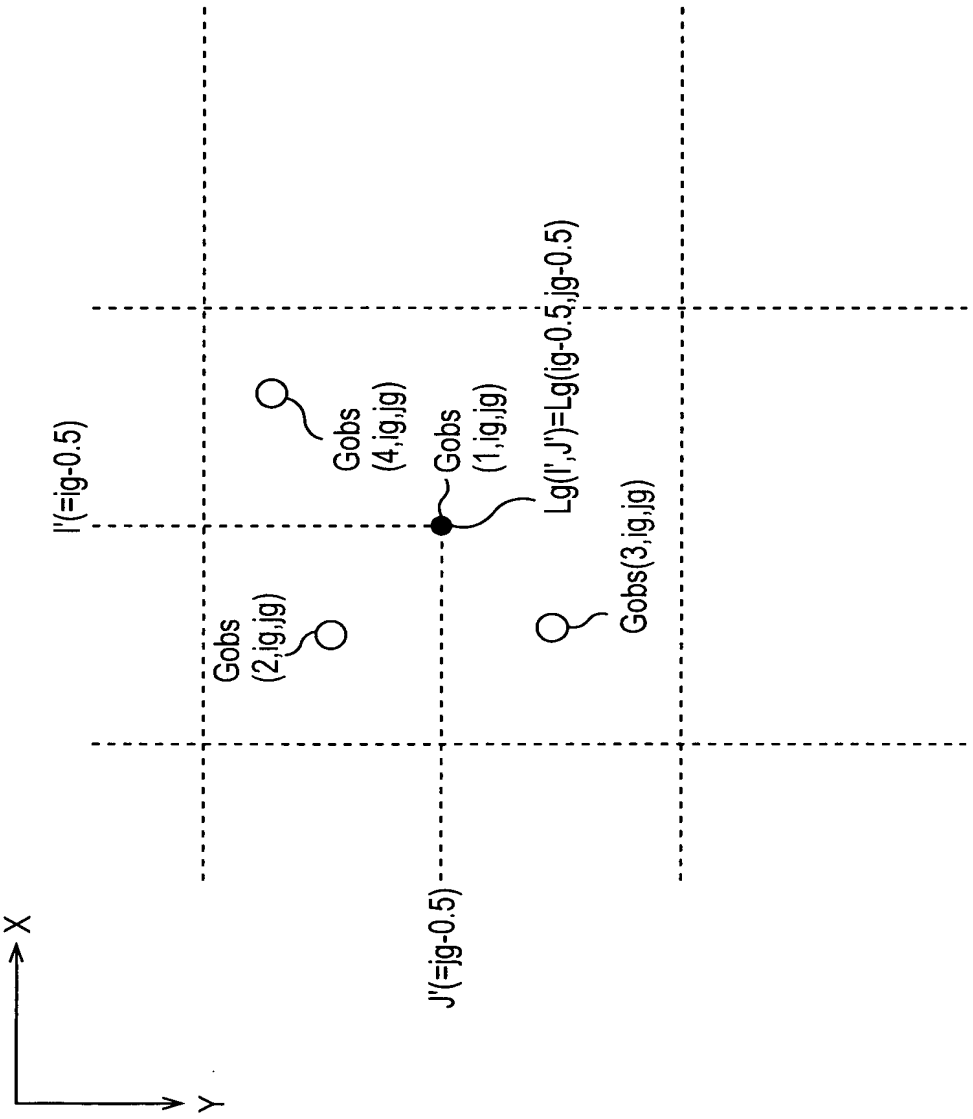
I'(=ig-0.5)
J'(=jg-0.5)
Gobs (4,ig,jg)
Gobs (1,ig,jg)
Lg(I',J')=Lg(ig-0.5,jg-0.5)
Gobs (2,ig,jg)
Gobs(3,ig,jg)
X
Y

FIG. 17

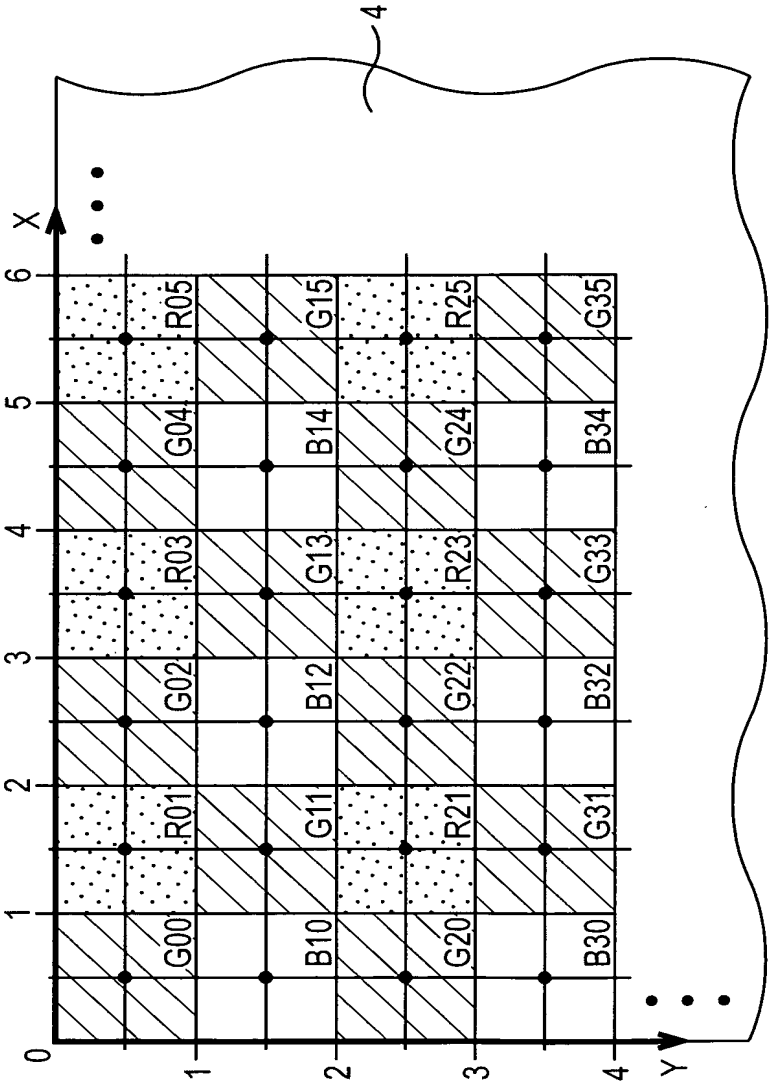
4
X
Y
0
1
2
3
4
5
6
G00
R01
G02
R03
G04
R05
B10
G11
B12
G13
B14
G15
G20
R21
G22
R23
G24
R25
B30
G31
B32
G33
B34
G35

FIG. 18

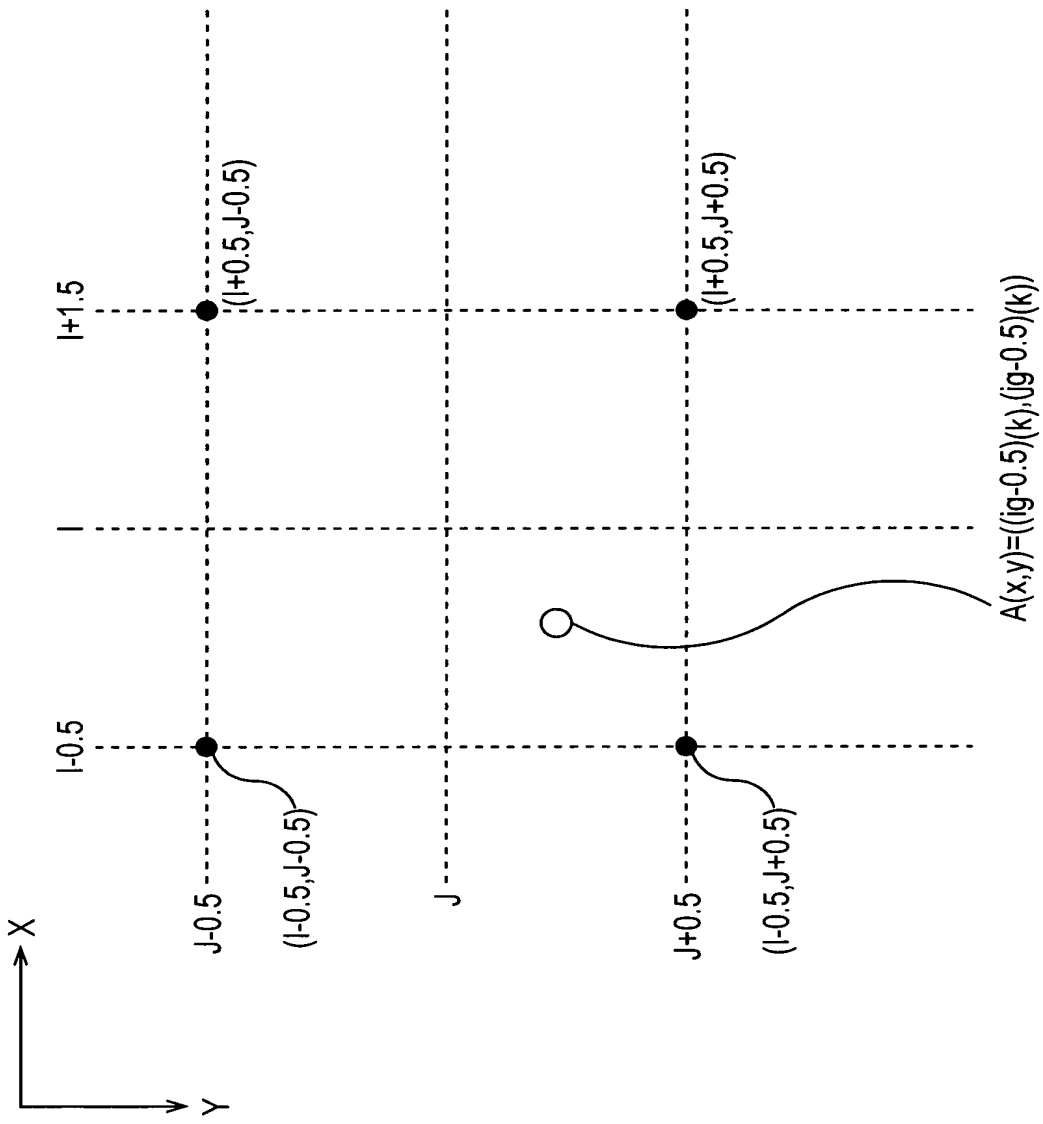
I+1.5
I
I-0.5
J-0.5
J
J+0.5
(I+0.5,J-0.5)
(I+0.5,J+0.5)
(I-0.5,J-0.5)
(I-0.5,J+0.5)
A(x,y)=((ig-0.5)(k),(jg-0.5)(k))
X
Y

FIG. 19

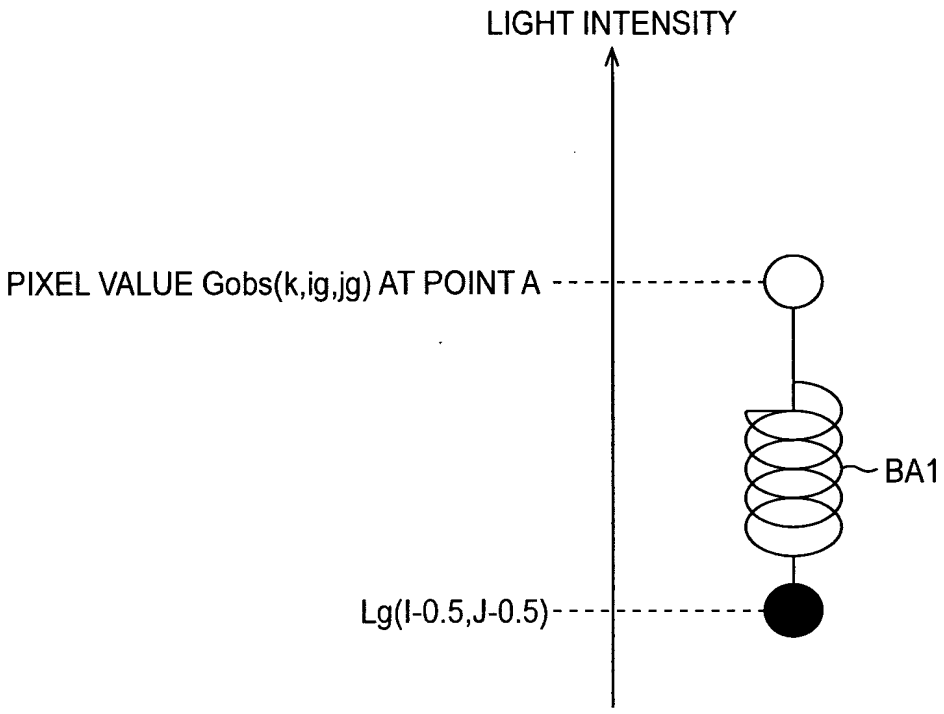
LIGHT INTENSITY
PIXEL VALUE Gobs(k,ig,jg) AT POINT A
BA1
Lg(I-0.5,J-0.5)

FIG. 20

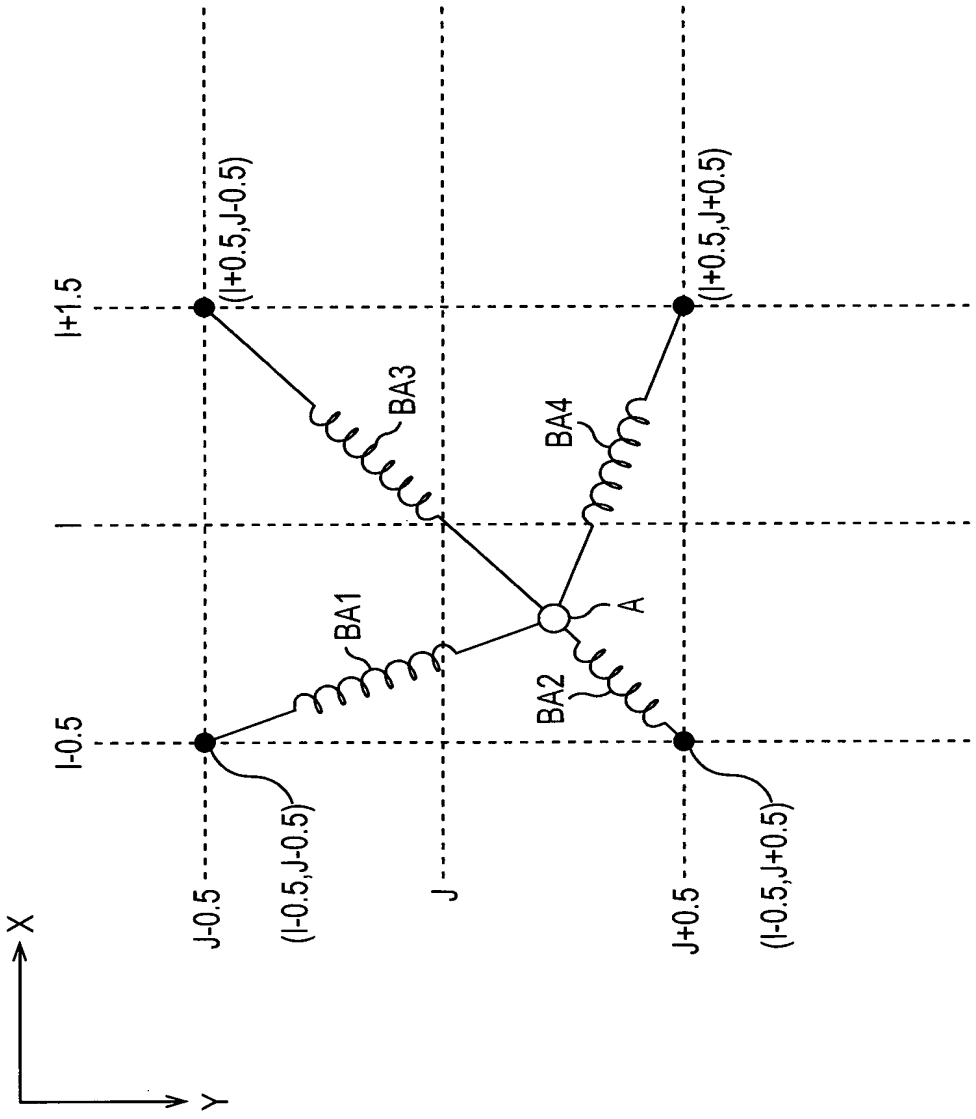
I+1.5
I
I-0.5
J-0.5
J
J+0.5
(I+0.5,J-0.5)
(I+0.5,J+0.5)
(I-0.5,J-0.5)
(I-0.5,J+0.5)
BA1
BA2
BA3
BA4
A
X
Y

FIG. 21

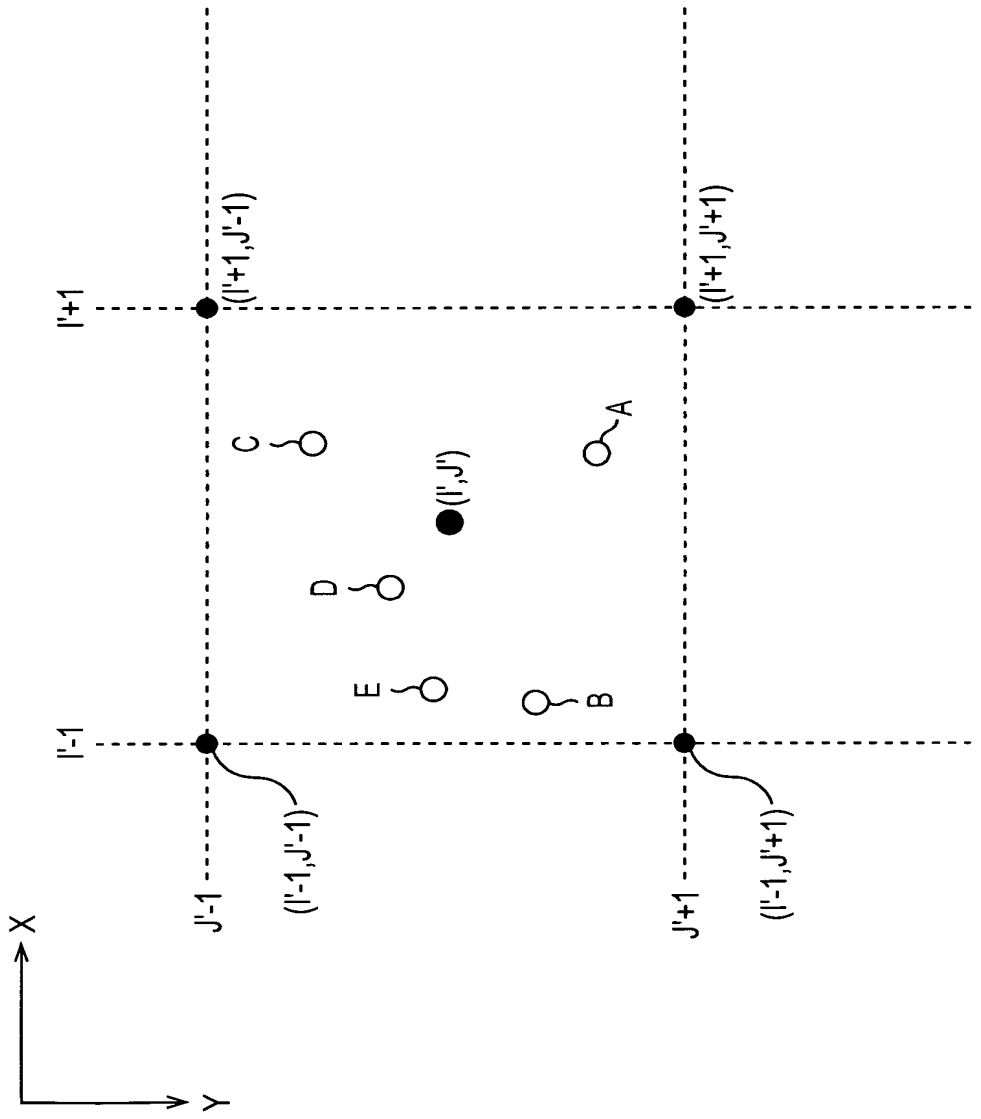

FIG. 22

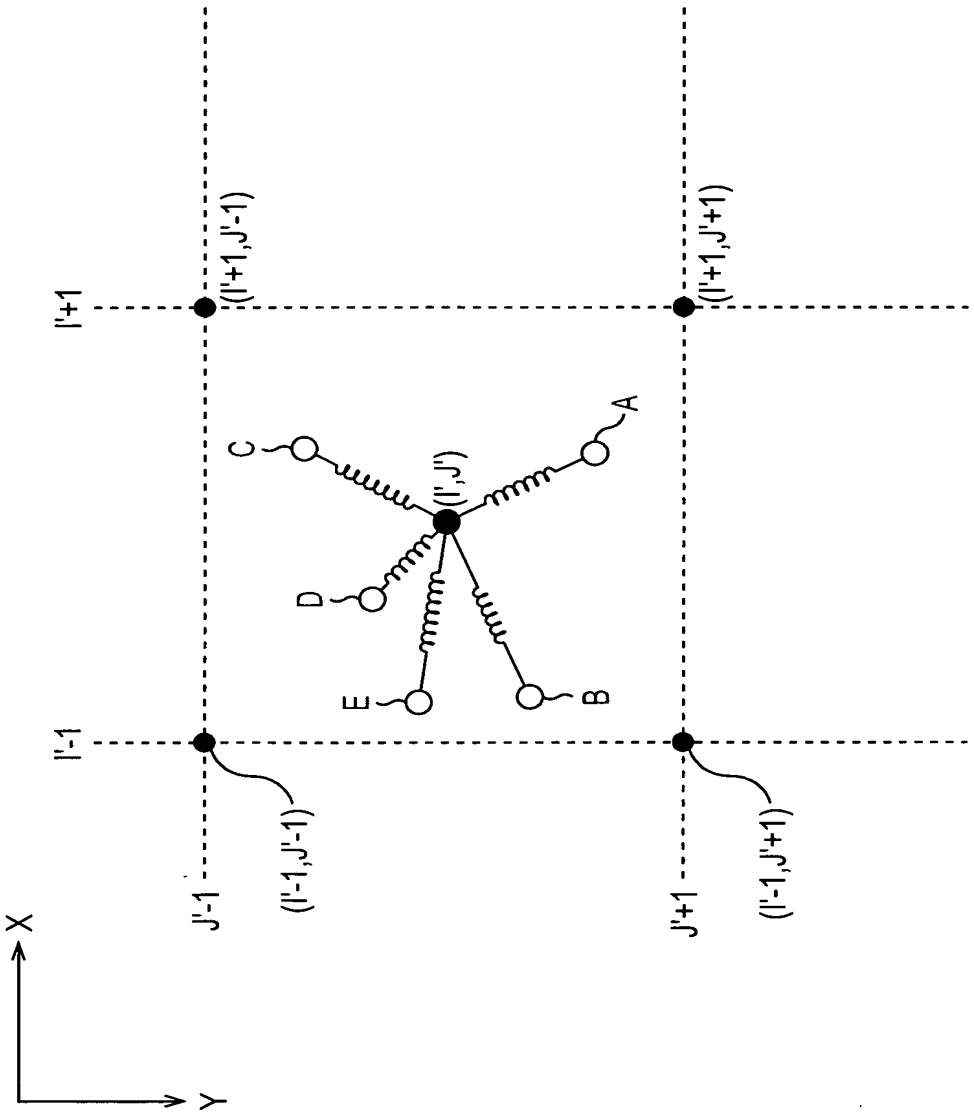

FIG. 23

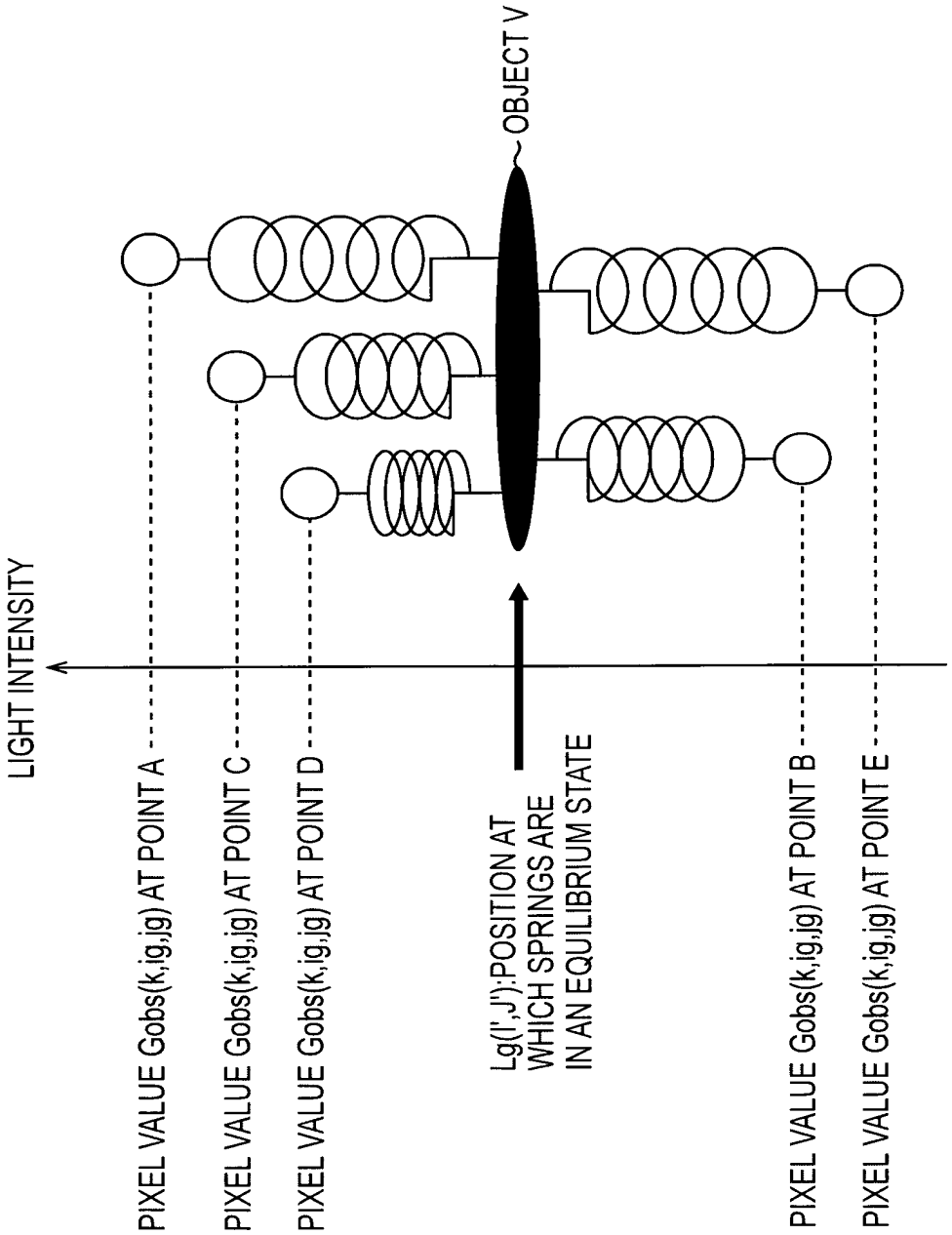
OBJECT V
LIGHT INTENSITY
PIXEL VALUE Gobs(k,ig,jg) AT POINT A
PIXEL VALUE Gobs(k,ig,jg) AT POINT C
PIXEL VALUE Gobs(k,ig,jg) AT POINT D
Lg(I',J'):POSITION AT
WHICH SPRINGS ARE
IN AN EQUILIBRIUM STATE
PIXEL VALUE Gobs(k,ig,jg) AT POINT B
PIXEL VALUE Gobs(k,ig,jg) AT POINT E

FIG. 24

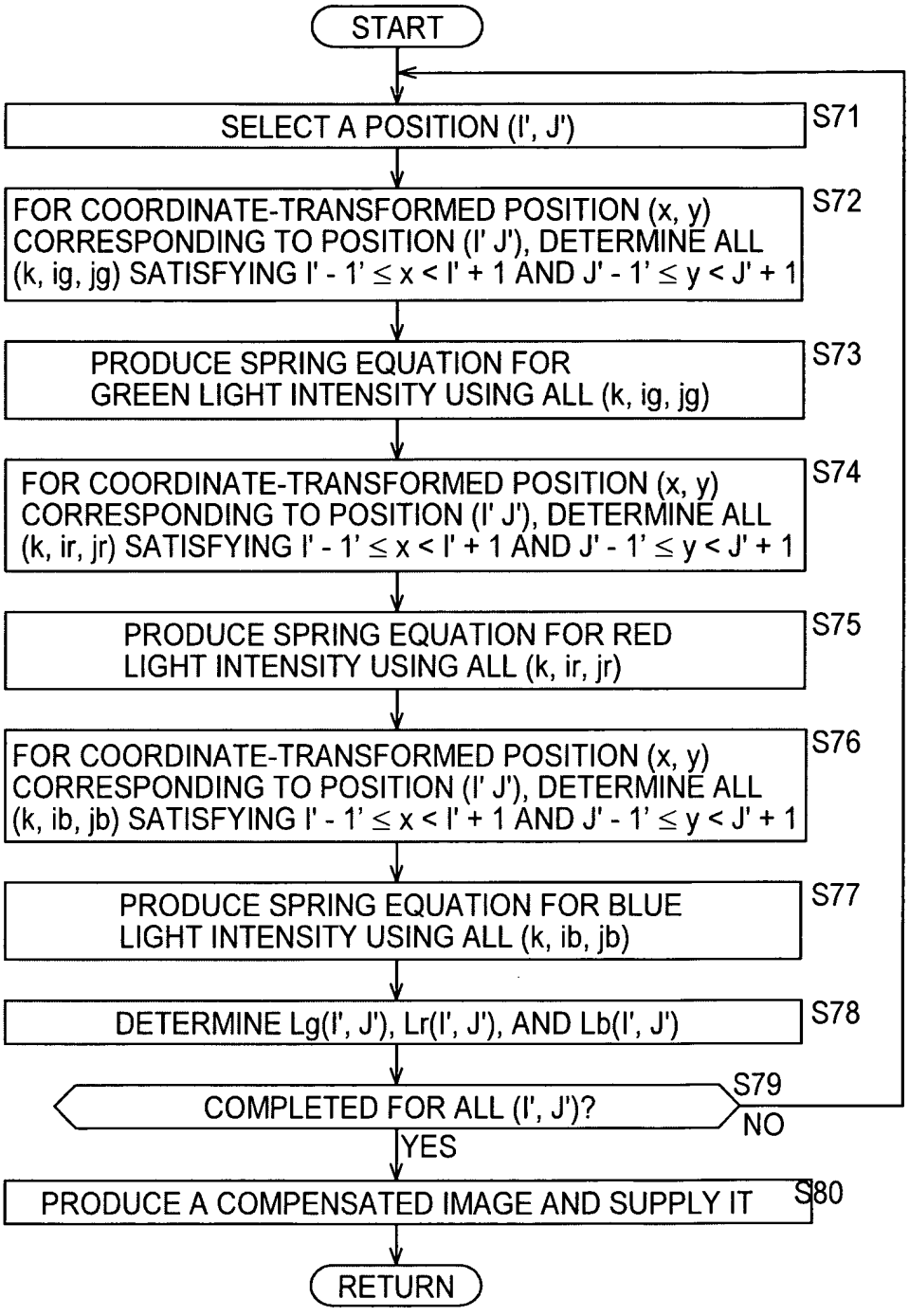
START
SELECT A POSITION (I', J')
S71
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ig, jg) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S72
PRODUCE SPRING EQUATION FOR GREEN LIGHT INTENSITY USING ALL (k, ig, jg)
S73
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ir, jr) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S74
PRODUCE SPRING EQUATION FOR RED LIGHT INTENSITY USING ALL (k, ir, jr)
S75
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ib, jb) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S76
PRODUCE SPRING EQUATION FOR BLUE LIGHT INTENSITY USING ALL (k, ib, jb)
S77
DETERMINE Lg(I', J'), Lr(I', J'), AND Lb(I', J')
S78
COMPLETED FOR ALL (I', J')?
S79
NO
YES
PRODUCE A COMPENSATED IMAGE AND SUPPLY IT
S80
RETURN

FIG. 25

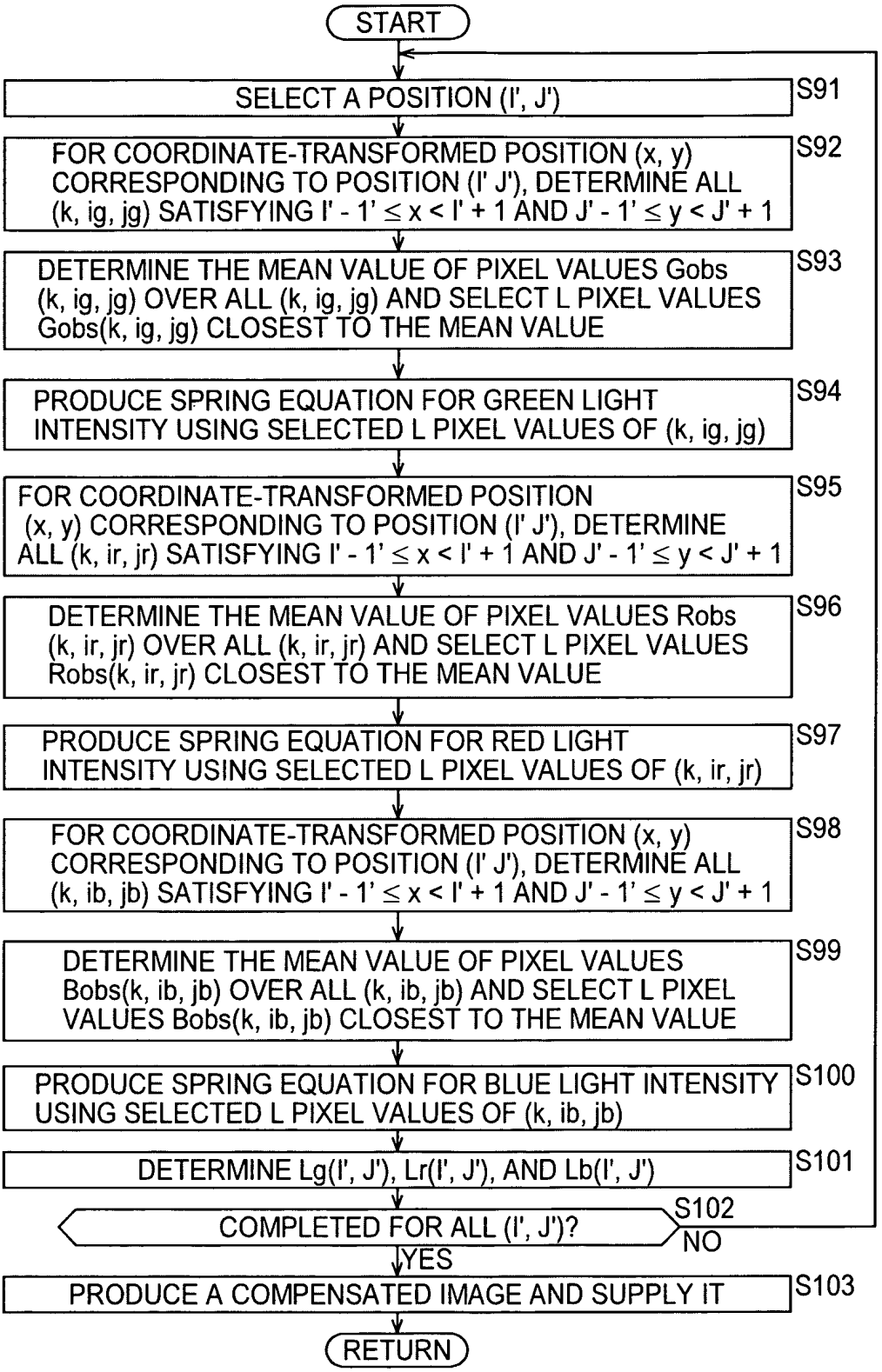
START
SELECT A POSITION (I', J')
S91
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ig, jg) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S92
DETERMINE THE MEAN VALUE OF PIXEL VALUES Gobs (k, ig, jg) OVER ALL (k, ig, jg) AND SELECT L PIXEL VALUES Gobs(k, ig, jg) CLOSEST TO THE MEAN VALUE
S93
PRODUCE SPRING EQUATION FOR GREEN LIGHT INTENSITY USING SELECTED L PIXEL VALUES OF (k, ig, jg)
S94
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ir, jr) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S95
DETERMINE THE MEAN VALUE OF PIXEL VALUES Robs (k, ir, jr) OVER ALL (k, ir, jr) AND SELECT L PIXEL VALUES Robs(k, ir, jr) CLOSEST TO THE MEAN VALUE
S96
PRODUCE SPRING EQUATION FOR RED LIGHT INTENSITY USING SELECTED L PIXEL VALUES OF (k, ir, jr)
S97
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ib, jb) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S98
DETERMINE THE MEAN VALUE OF PIXEL VALUES Bobs(k, ib, jb) OVER ALL (k, ib, jb) AND SELECT L PIXEL VALUES Bobs(k, ib, jb) CLOSEST TO THE MEAN VALUE
S99
PRODUCE SPRING EQUATION FOR BLUE LIGHT INTENSITY USING SELECTED L PIXEL VALUES OF (k, ib, jb)
S100
DETERMINE Lg(I', J'), Lr(I', J'), AND Lb(I', J')
S101
COMPLETED FOR ALL (I', J')?
S102
NO
YES
PRODUCE A COMPENSATED IMAGE AND SUPPLY IT
S103
RETURN

FIG. 26

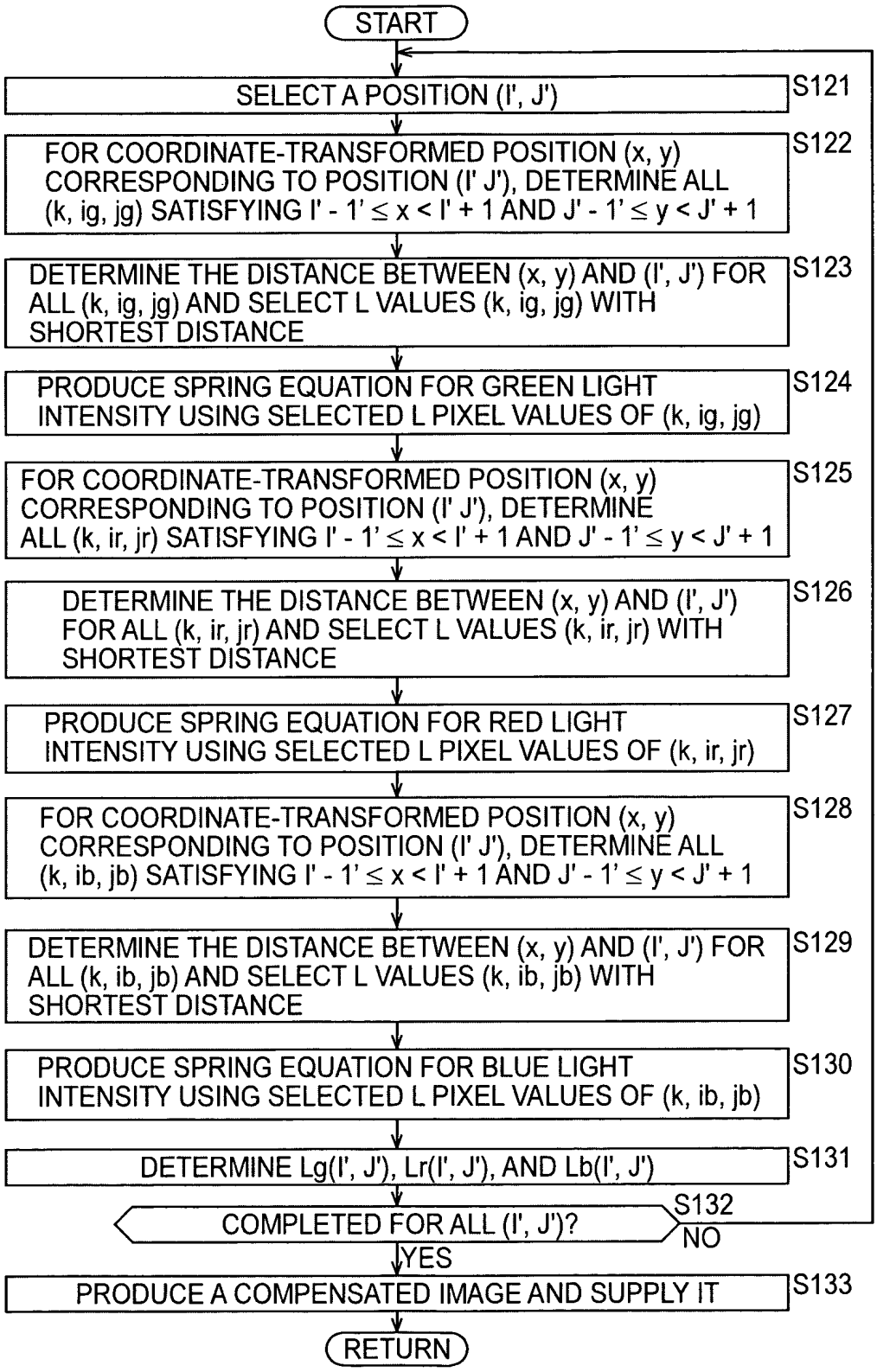
START
SELECT A POSITION (I', J')
S121
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ig, jg) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S122
DETERMINE THE DISTANCE BETWEEN (x, y) AND (I', J') FOR ALL (k, ig, jg) AND SELECT L VALUES (k, ig, jg) WITH SHORTEST DISTANCE
S123
PRODUCE SPRING EQUATION FOR GREEN LIGHT INTENSITY USING SELECTED L PIXEL VALUES OF (k, ig, jg)
S124
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ir, jr) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S125
DETERMINE THE DISTANCE BETWEEN (x, y) AND (I', J') FOR ALL (k, ir, jr) AND SELECT L VALUES (k, ir, jr) WITH SHORTEST DISTANCE
S126
PRODUCE SPRING EQUATION FOR RED LIGHT INTENSITY USING SELECTED L PIXEL VALUES OF (k, ir, jr)
S127
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ib, jb) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S128
DETERMINE THE DISTANCE BETWEEN (x, y) AND (I', J') FOR ALL (k, ib, jb) AND SELECT L VALUES (k, ib, jb) WITH SHORTEST DISTANCE
S129
PRODUCE SPRING EQUATION FOR BLUE LIGHT INTENSITY USING SELECTED L PIXEL VALUES OF (k, ib, jb)
S130
DETERMINE Lg(I', J'), Lr(I', J'), AND Lb(I', J')
S131
COMPLETED FOR ALL (I', J')?
S132
NO
YES
PRODUCE A COMPENSATED IMAGE AND SUPPLY IT
S133
RETURN

FIG. 27

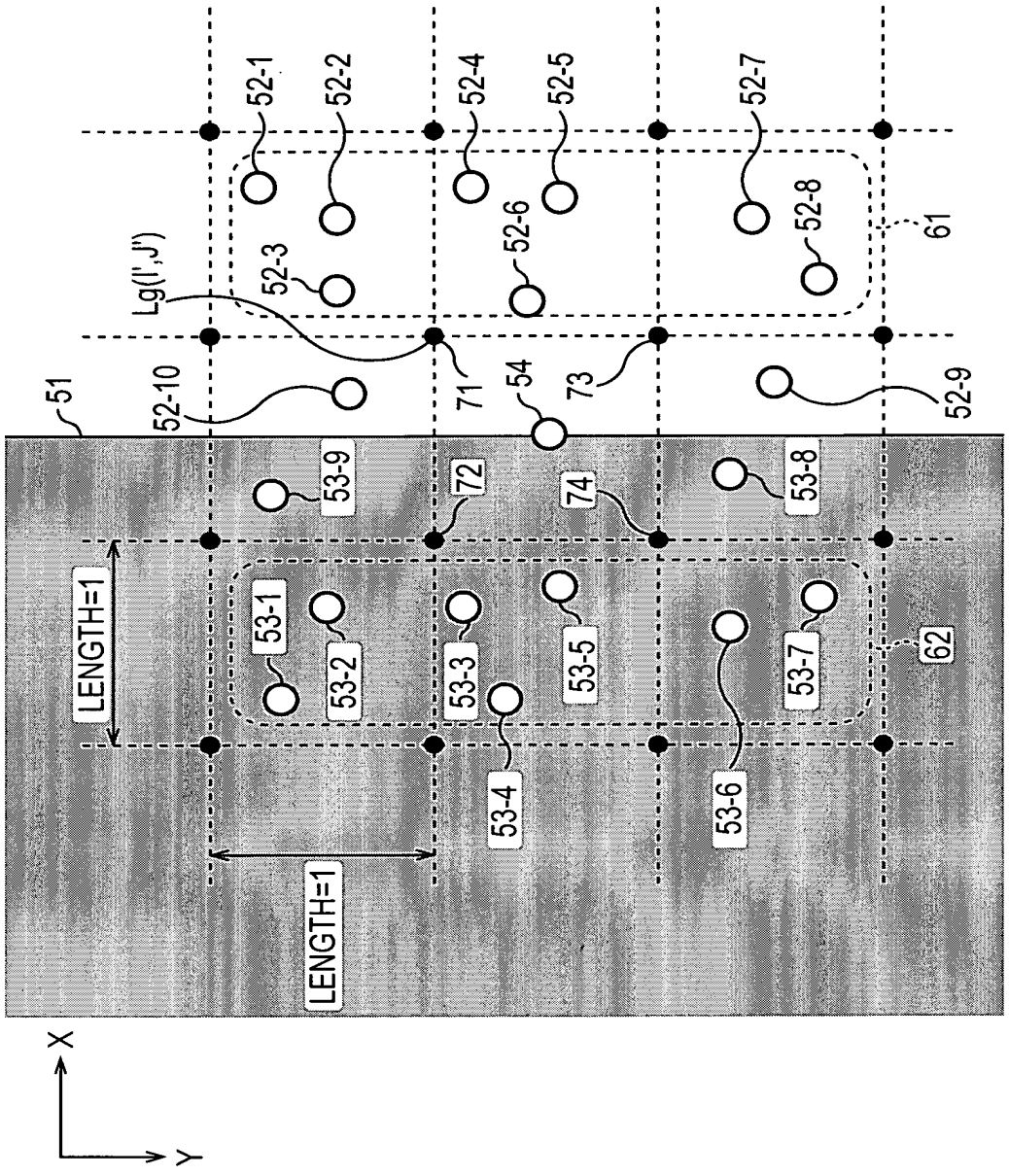
51
52-1
52-2
52-3
52-4
52-5
52-6
52-7
52-8
52-9
52-10
61
62
71
72
73
74
54
Lg(I',J')
LENGTH=1
LENGTH=1
53-1
53-2
53-3
53-4
53-5
53-6
53-7
53-8
53-9
X
Y

FIG. 28

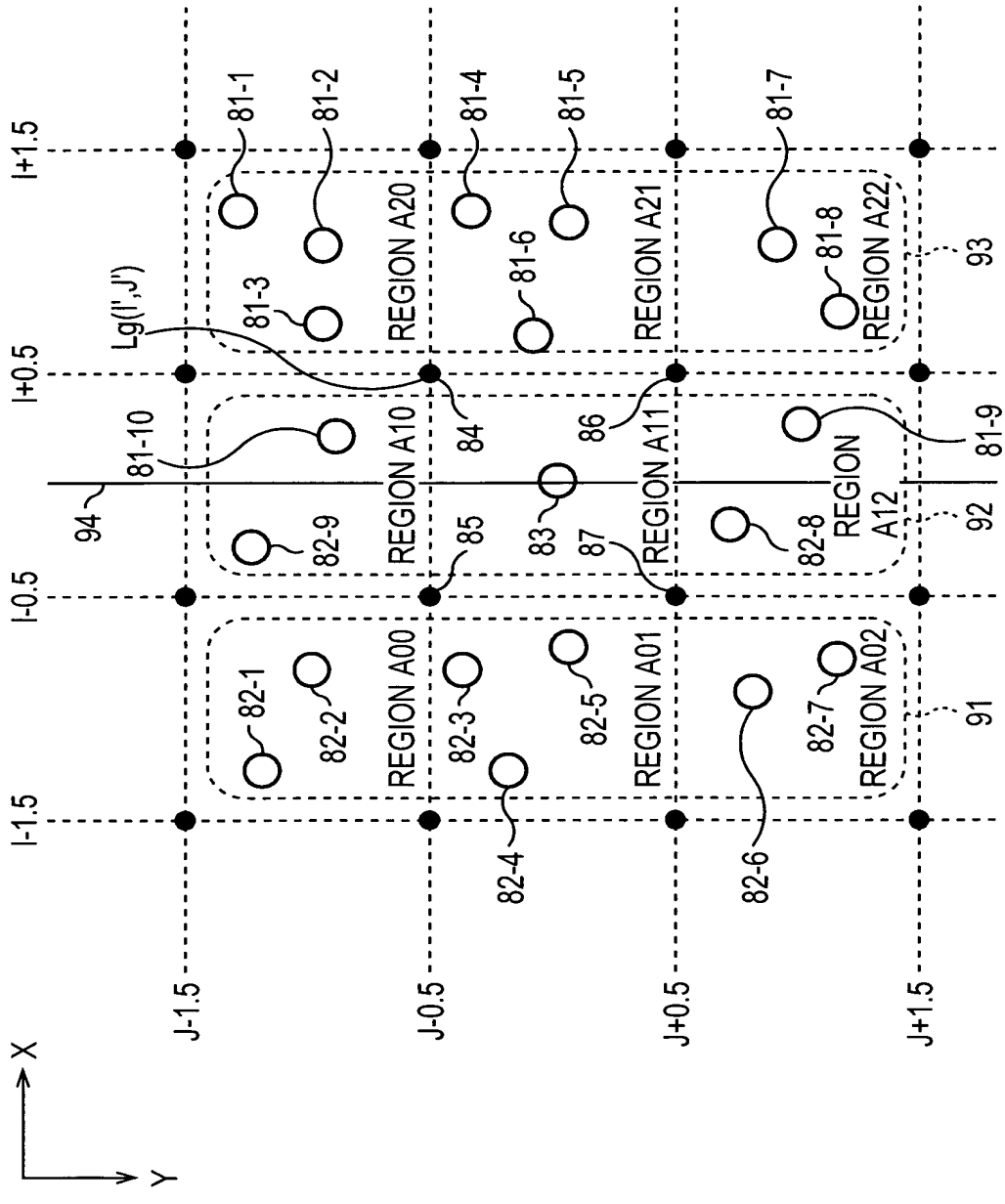
I+1.5
I+0.5
I-0.5
I-1.5
J-1.5
J-0.5
J+0.5
J+1.5
X
Y
Lg(I',J')
81-1
81-2
81-3
81-4
81-5
81-6
81-7
81-8
81-9
81-10
82-1
82-2
82-3
82-4
82-5
82-6
82-7
82-8
82-9
83
84
85
86
87
91
92
93
94
REGION A00
REGION A01
REGION A02
REGION A10
REGION A11
REGION A12
REGION A20
REGION A21
REGION A22

FIG. 29

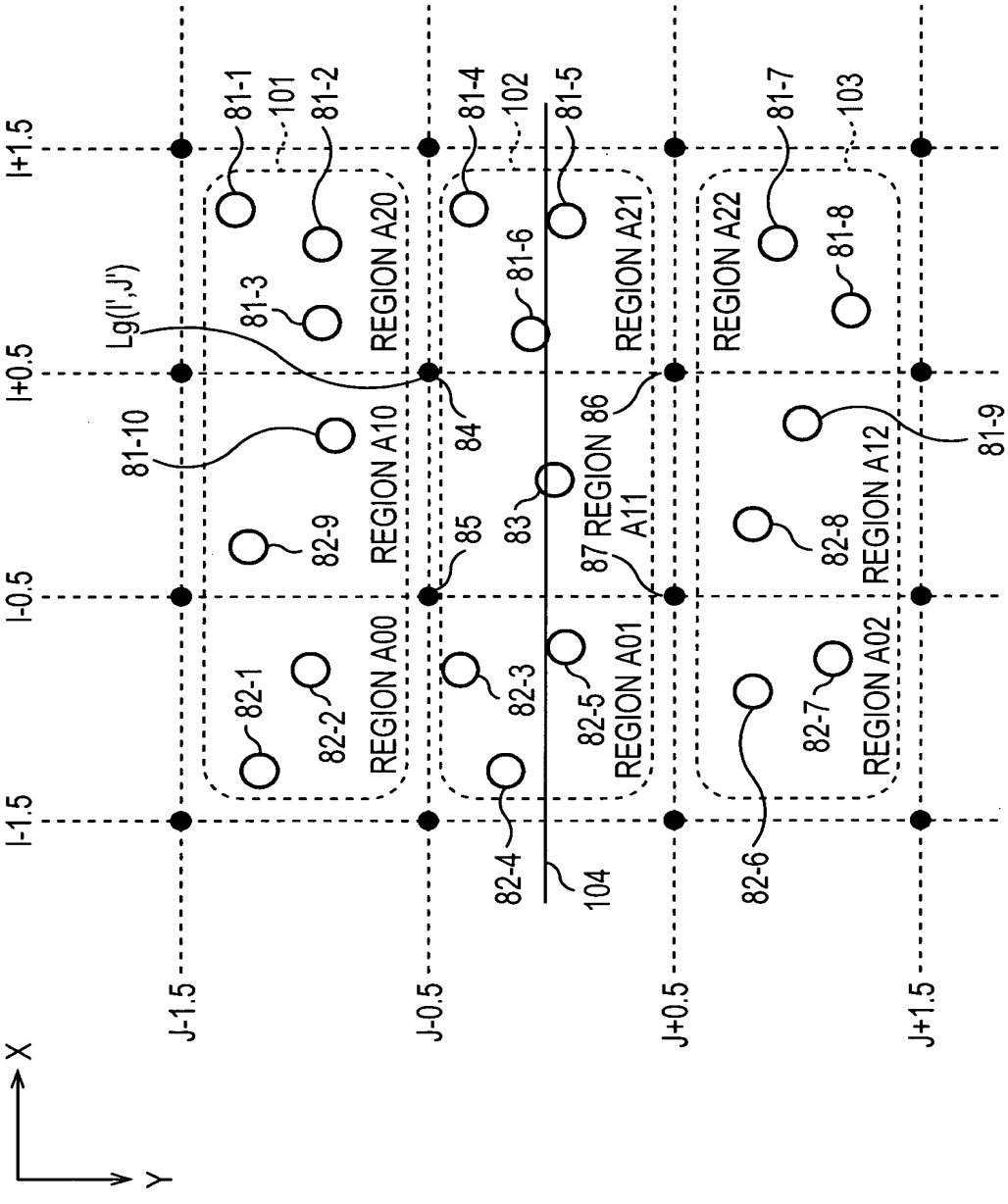
I+1.5
I+0.5
I-0.5
I-1.5
J-1.5
J-0.5
J+0.5
J+1.5
X
Y
Lg(I',J')
81-1
101
81-2
81-3
81-4
102
81-5
81-6
81-7
103
81-8
81-9
81-10
82-1
82-2
82-3
82-4
82-5
82-6
82-7
82-8
82-9
83
84
85
87
REGION 86
REGION A00
REGION A01
REGION A02
REGION A10
REGION A11
REGION A12
REGION A20
REGION A21
REGION A22
104

FIG. 30

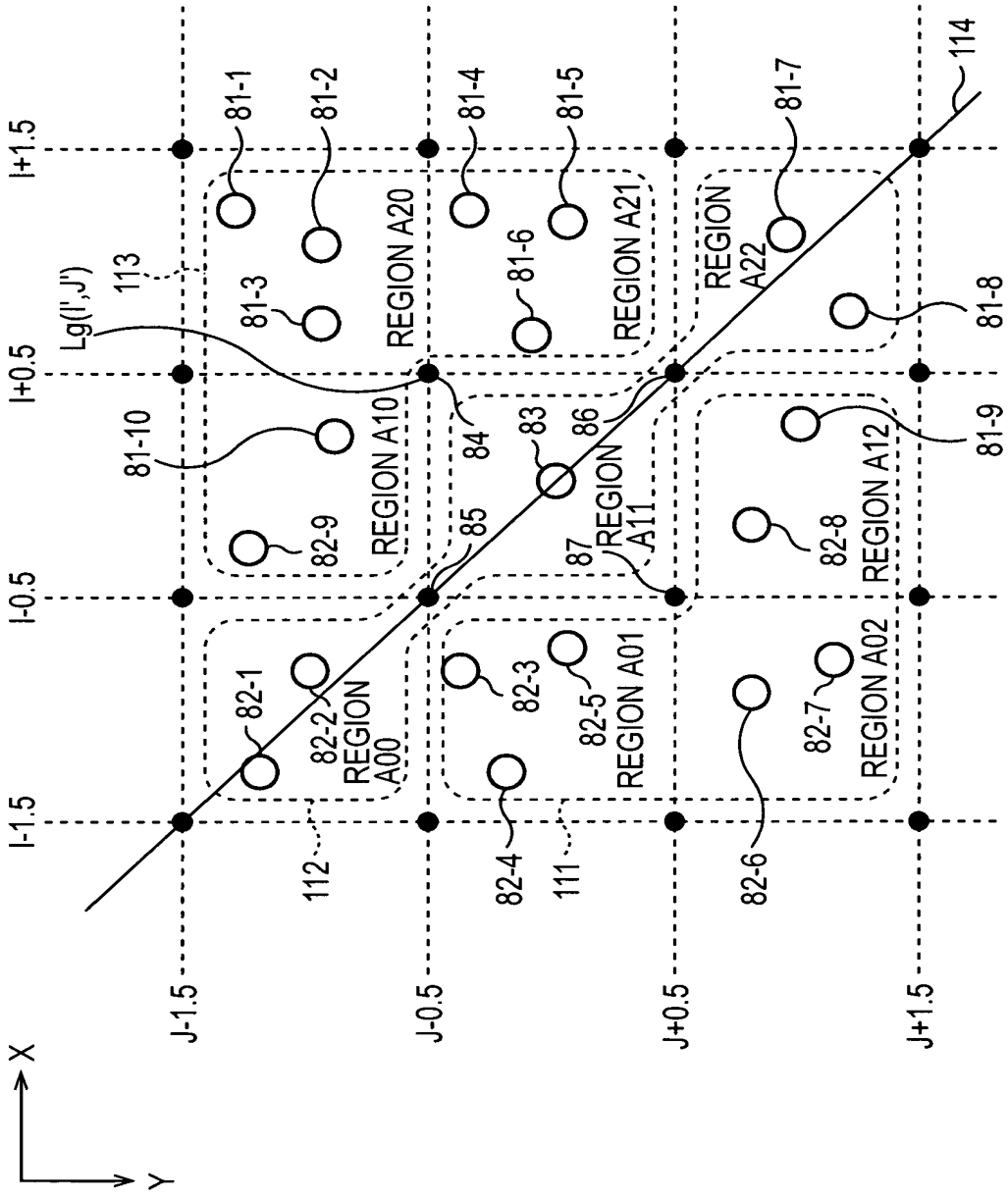
I+1.5
I+0.5
I-0.5
I-1.5
J-1.5
J-0.5
J+0.5
J+1.5
X
Y
Lg(I',J')
113
114
81-1
81-2
81-3
81-4
81-5
81-6
81-7
81-8
81-9
81-10
REGION A20
REGION A21
REGION A22
REGION A10
REGION A11
REGION A12
REGION A00
REGION A01
REGION A02
82-1
82-2
82-3
82-4
82-5
82-6
82-7
82-8
82-9
83
84
85
86
87
111
112

FIG. 31

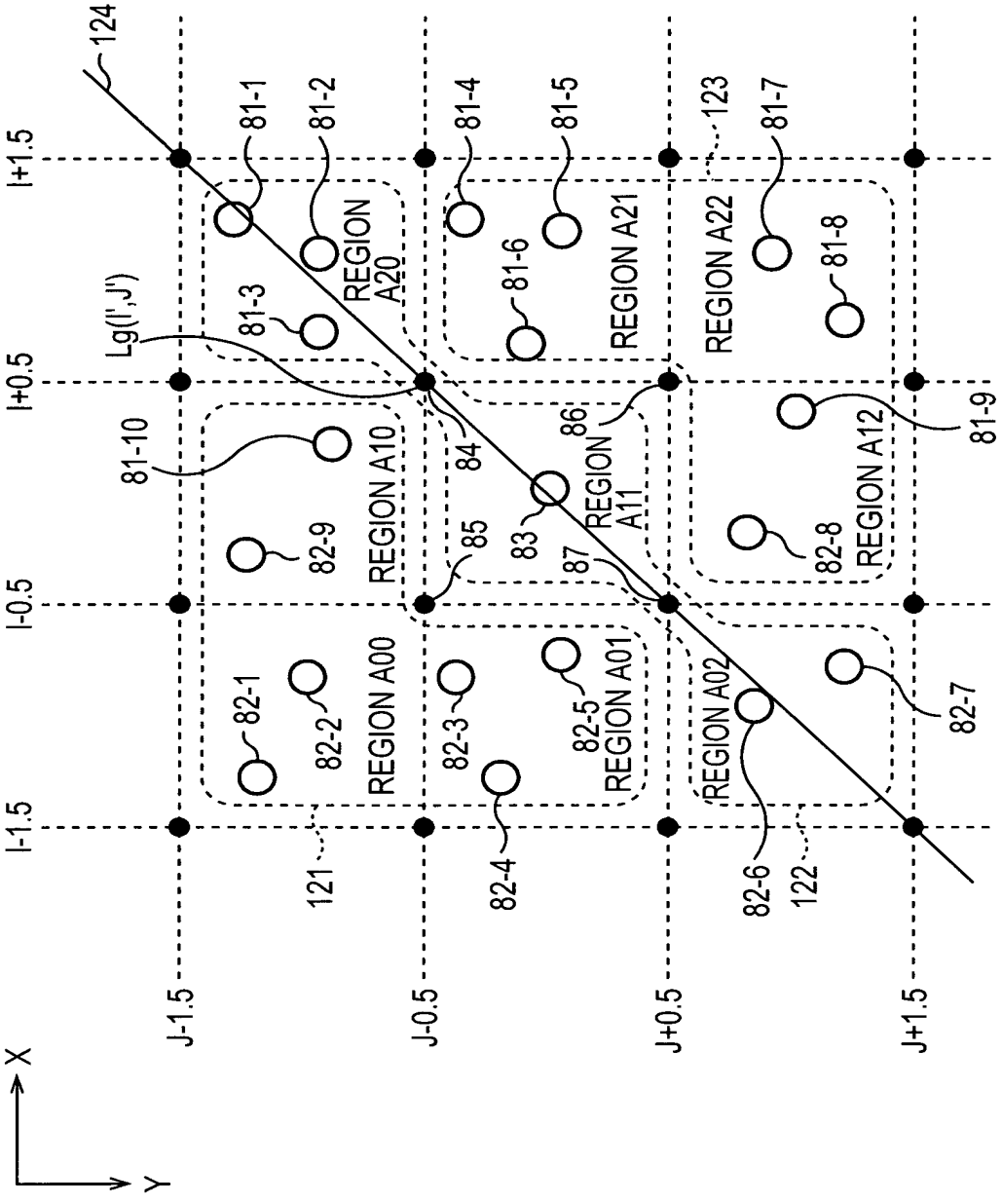
124
I+1.5
I+0.5
I-0.5
I-1.5
J-1.5
J-0.5
J+0.5
J+1.5
Lg(I',J')
81-1
81-2
81-3
81-4
81-5
81-6
81-7
81-8
81-9
81-10
123
REGION A20
REGION A21
REGION A22
REGION A10
REGION A11
REGION A12
REGION A00
REGION A01
REGION A02
82-1
82-2
82-3
82-4
82-5
82-6
82-7
82-8
82-9
83
84
85
86
87
121
122
X
Y

FIG. 32

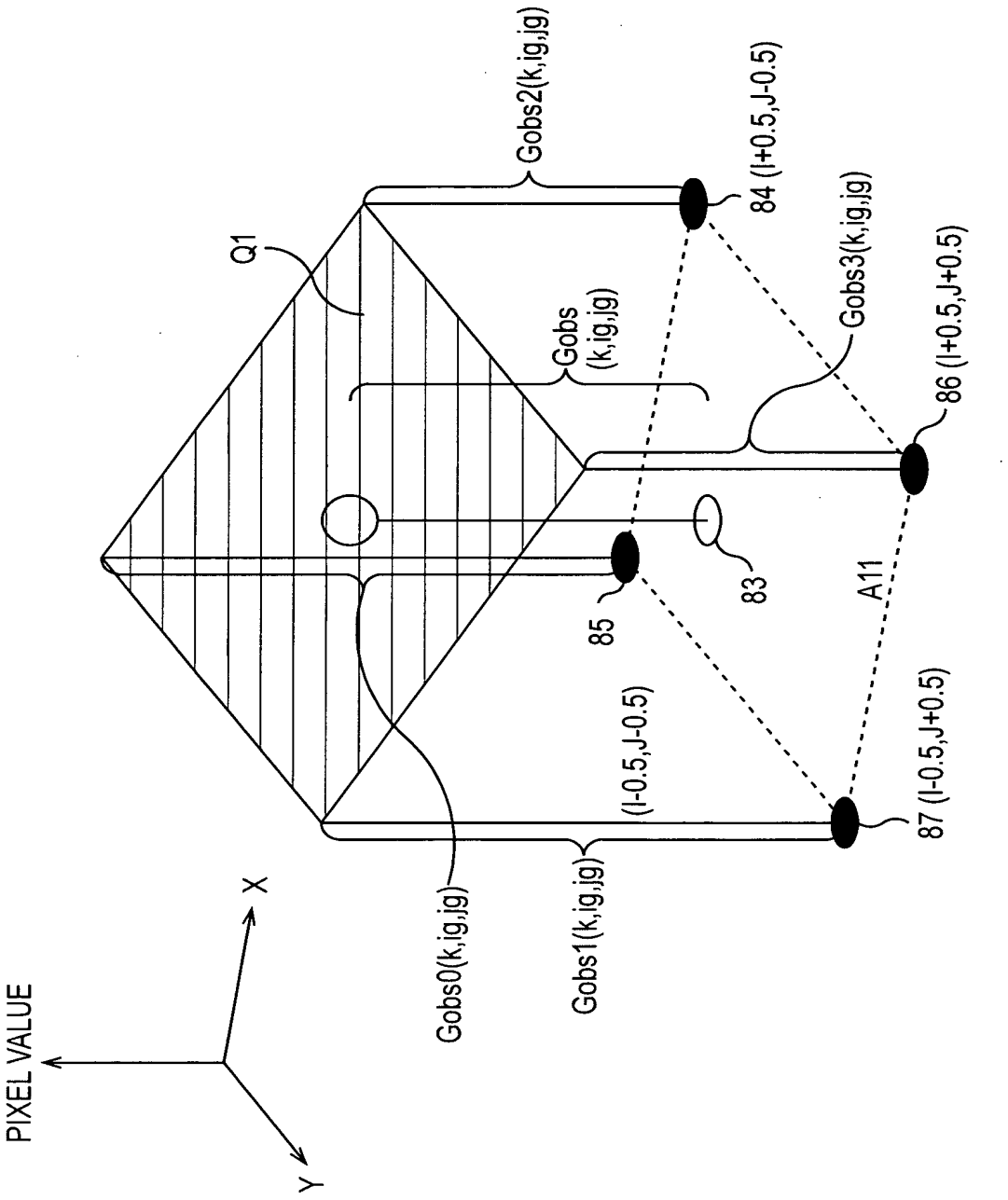
Gobs2(k,ig,jg)
84 (I+0.5,J-0.5)
Q1
Gobs3(k,ig,jg)
Gobs
(k,ig,jg)
86 (I+0.5,J+0.5)
83
85
A11
(I-0.5,J-0.5)
87 (I-0.5,J+0.5)
Gobs0(k,ig,jg)
Gobs1(k,ig,jg)
PIXEL VALUE
X
Y

FIG. 33

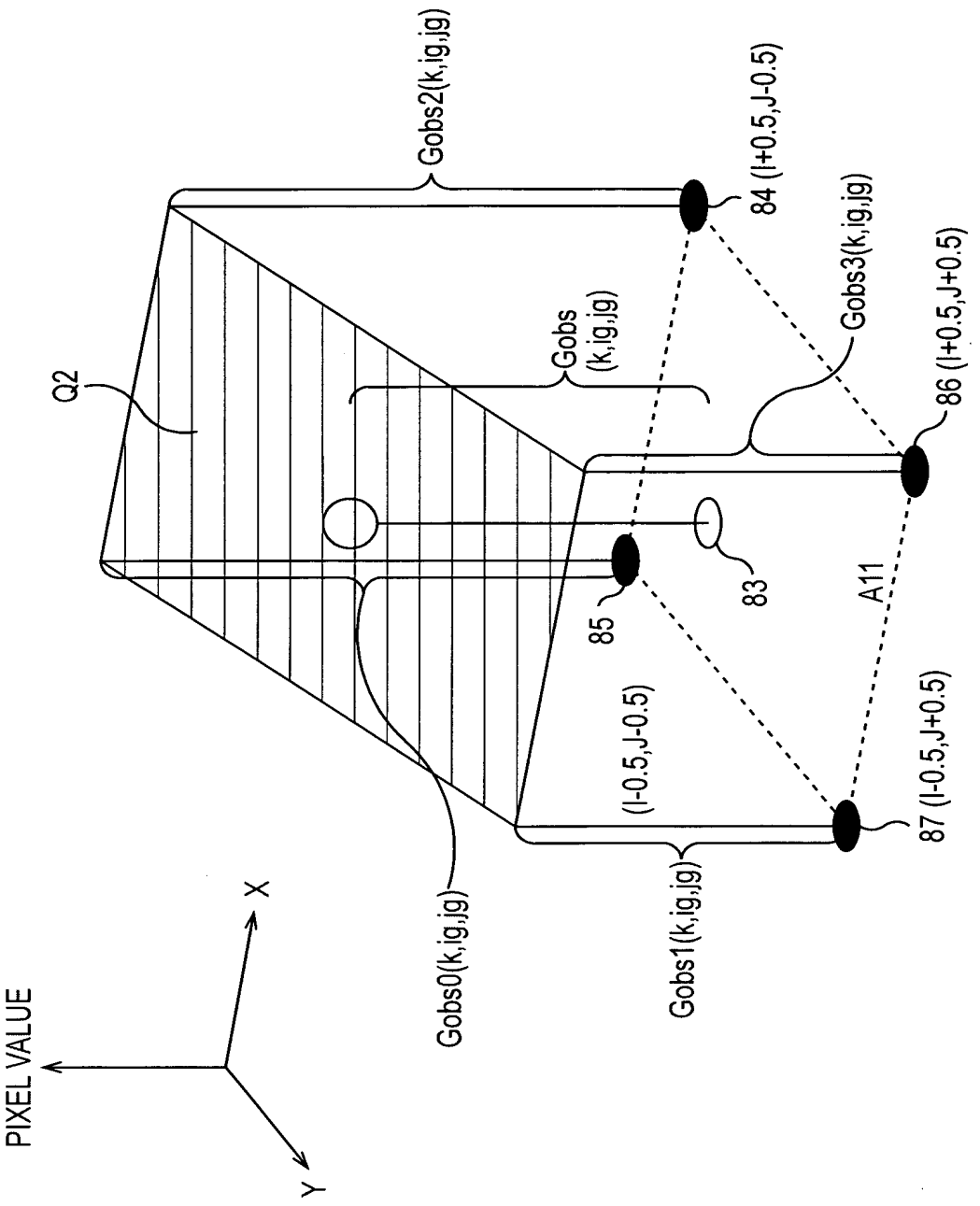
Gobs2(k,ig,jg)
84 (I+0.5,J-0.5)
Gobs3(k,ig,jg)
86 (I+0.5,J+0.5)
Gobs (k,ig,jg)
Q2
83
85
A11
(I-0.5,J-0.5)
87 (I-0.5,J+0.5)
Gobs0(k,ig,jg)
Gobs1(k,ig,jg)
PIXEL VALUE
X
Y

FIG. 34

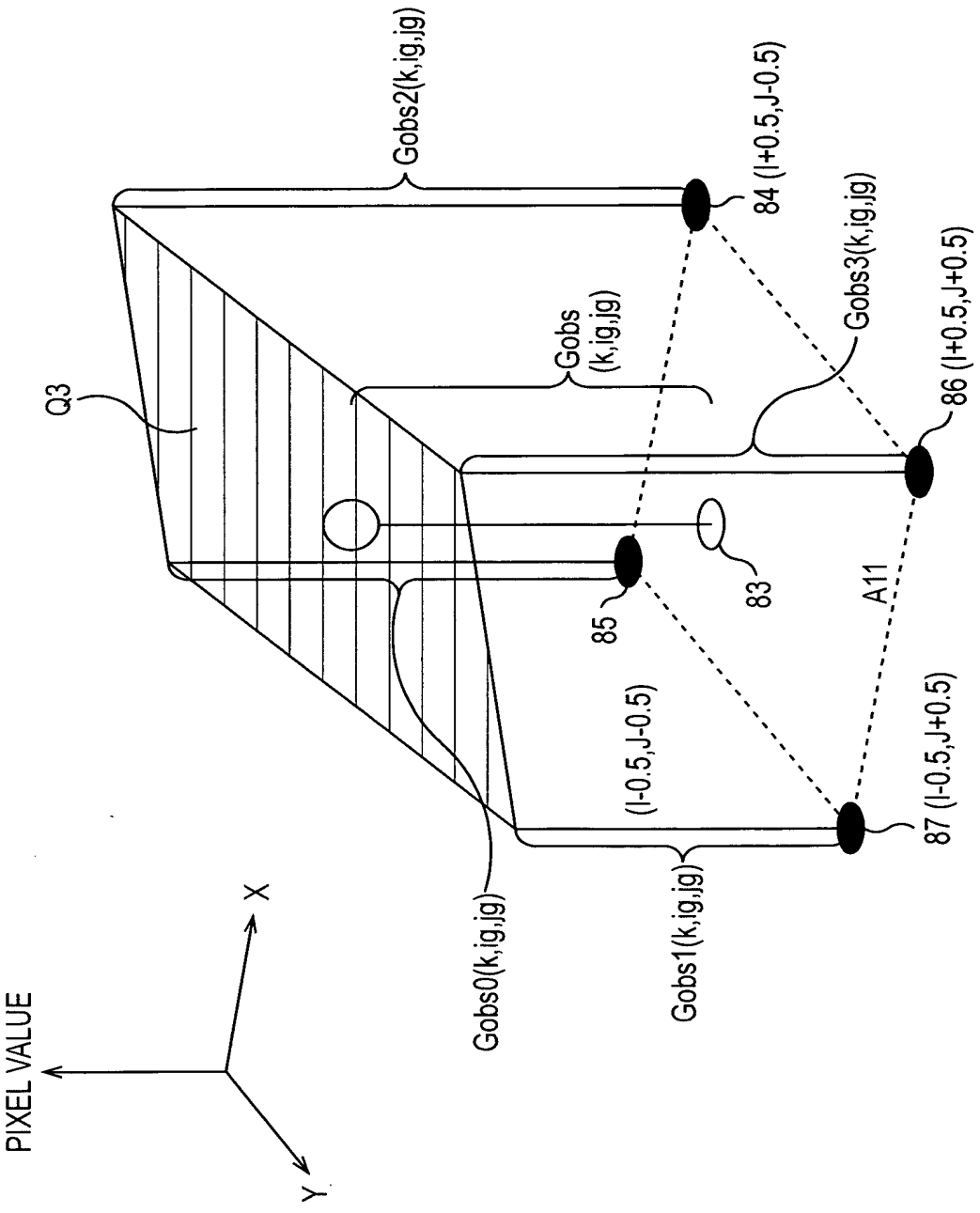
Gobs2(k,ig,jg)
84 (I+0.5,J-0.5)
Gobs3(k,ig,jg)
Gobs (k,ig,jg)
Q3
86 (I+0.5,J+0.5)
83
85
A11
(I-0.5,J-0.5)
87 (I-0.5,J+0.5)
Gobs0(k,ig,jg)
Gobs1(k,ig,jg)
PIXEL VALUE
X
Y

FIG. 35

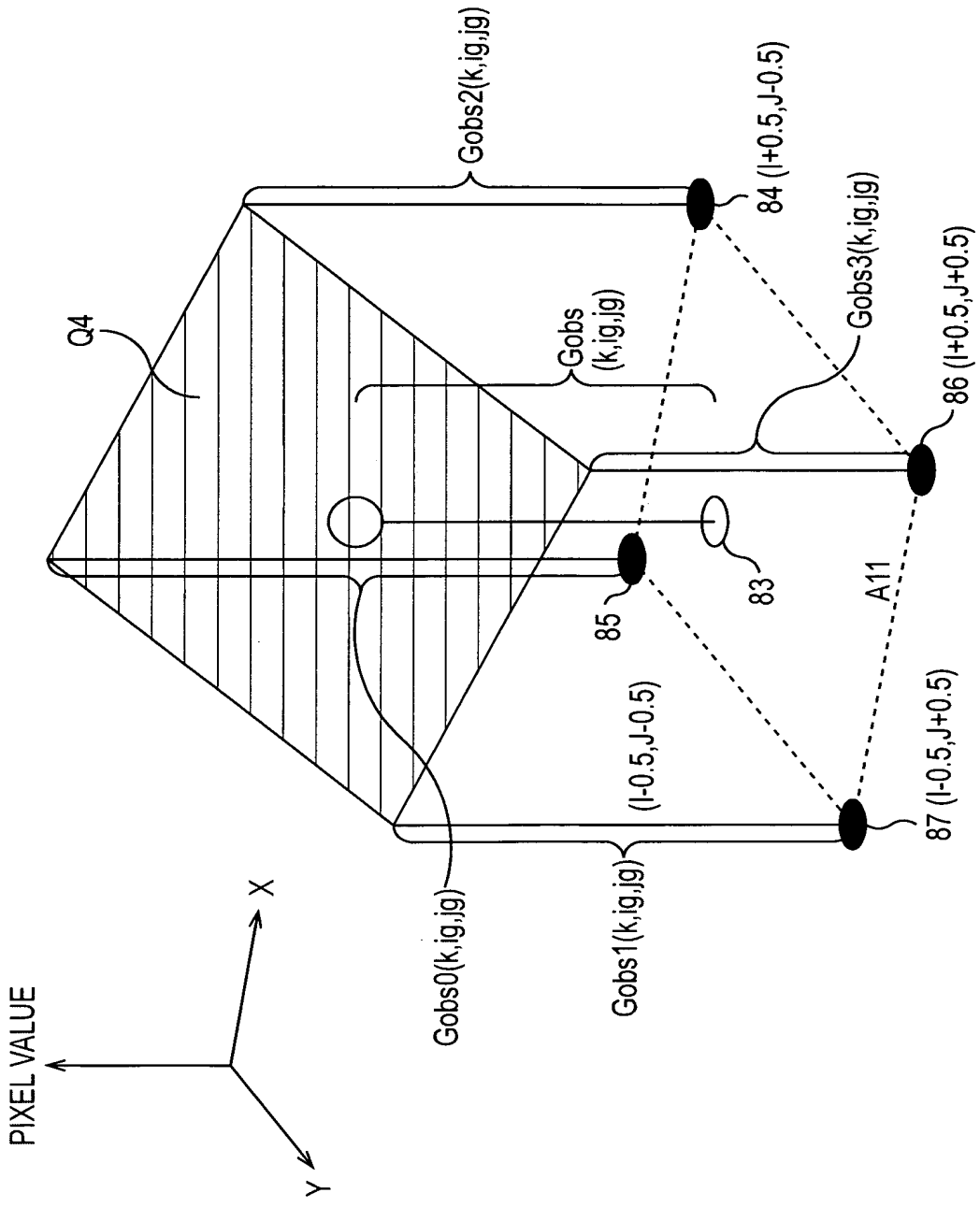
Gobs2(k,ig,jg)
84 (I+0.5,J-0.5)
Gobs3(k,ig,jg)
86 (I+0.5,J+0.5)
Q4
Gobs
(k,ig,jg)
83
85
A11
(I-0.5,J-0.5)
87 (I-0.5,J+0.5)
Gobs0(k,ig,jg)
Gobs1(k,ig,jg)
PIXEL VALUE
X
Y

FIG. 36

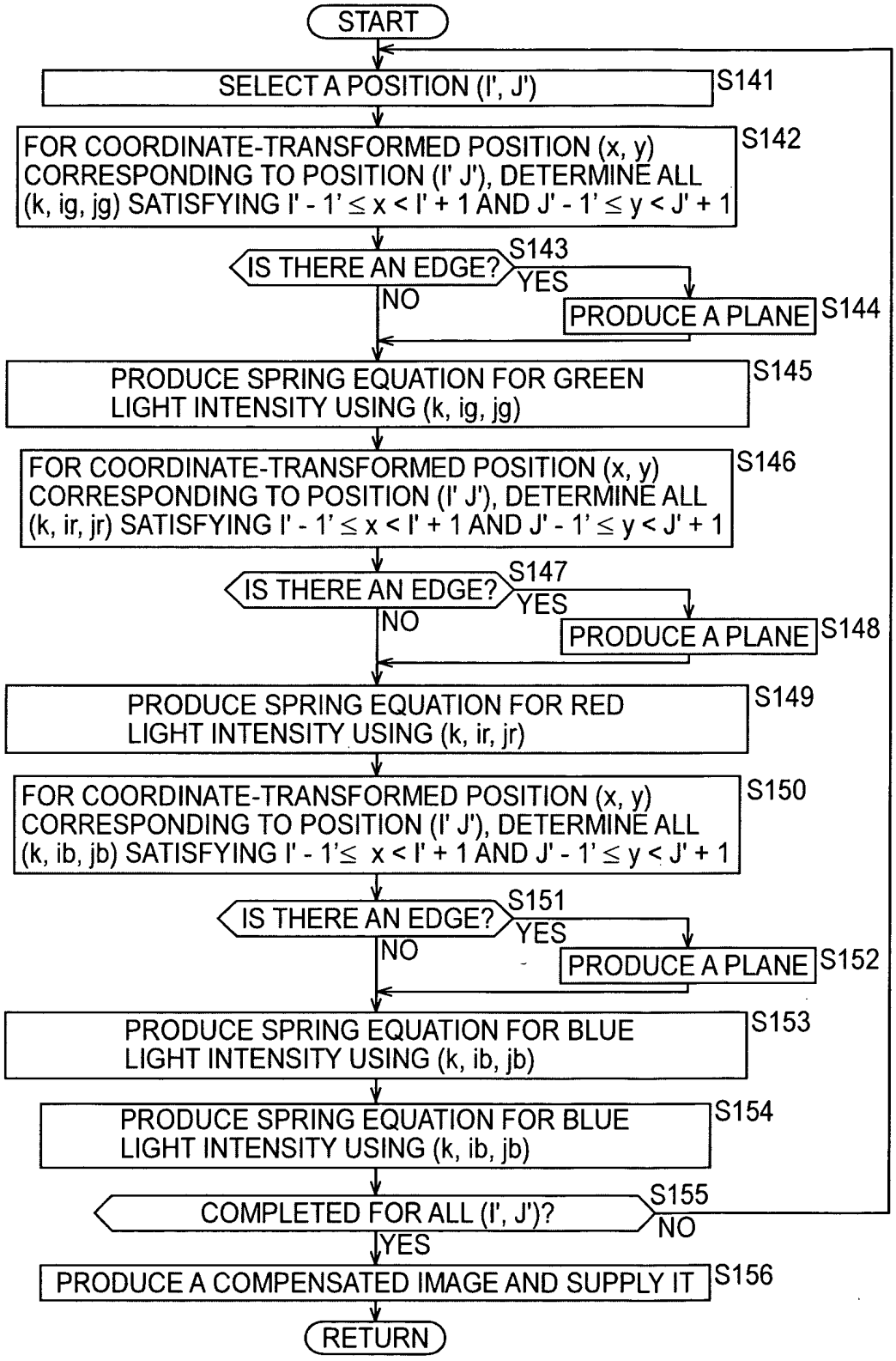
START
SELECT A POSITION (I', J')
S141
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ig, jg) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S142
IS THERE AN EDGE?
S143
YES
NO
PRODUCE A PLANE
S144
PRODUCE SPRING EQUATION FOR GREEN LIGHT INTENSITY USING (k, ig, jg)
S145
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ir, jr) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S146
IS THERE AN EDGE?
S147
YES
NO
PRODUCE A PLANE
S148
PRODUCE SPRING EQUATION FOR RED LIGHT INTENSITY USING (k, ir, jr)
S149
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ib, jb) SATISFYING I' - 1'≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S150
IS THERE AN EDGE?
S151
YES
NO
PRODUCE A PLANE
S152
PRODUCE SPRING EQUATION FOR BLUE LIGHT INTENSITY USING (k, ib, jb)
S153
PRODUCE SPRING EQUATION FOR BLUE LIGHT INTENSITY USING (k, ib, jb)
S154
COMPLETED FOR ALL (I', J')?
S155
NO
YES
PRODUCE A COMPENSATED IMAGE AND SUPPLY IT
S156
RETURN

FIG. 37

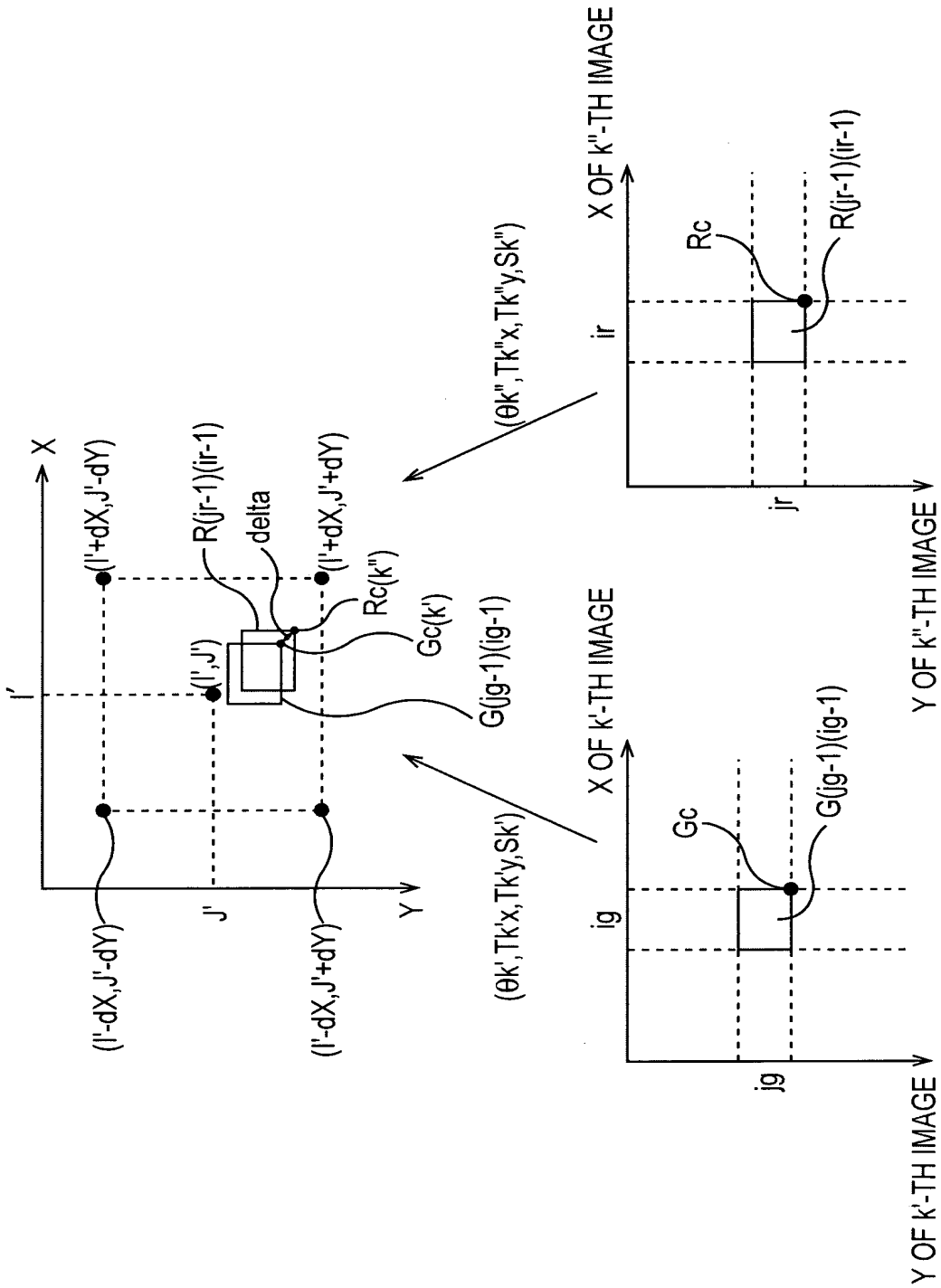
X
Y
I'
J'
(I'-dX,J'-dY)
(I'+dX,J'-dY)
(I'-dX,J'+dY)
(I'+dX,J'+dY)
(I',J')
R(jr-1)(ir-1)
delta
Rc(k")
Gc(k')
G(jg-1)(ig-1)
(θk",Tk"x,Tk"y,Sk")
(θk',Tk'x,Tk'y,Sk')
X OF k"-TH IMAGE
Y OF k"-TH IMAGE
X OF k'-TH IMAGE
Y OF k'-TH IMAGE
Rc
ir
jr
R(jr-1)(ir-1)
Gc
ig
jg
G(jg-1)(ig-1)

FIG. 38

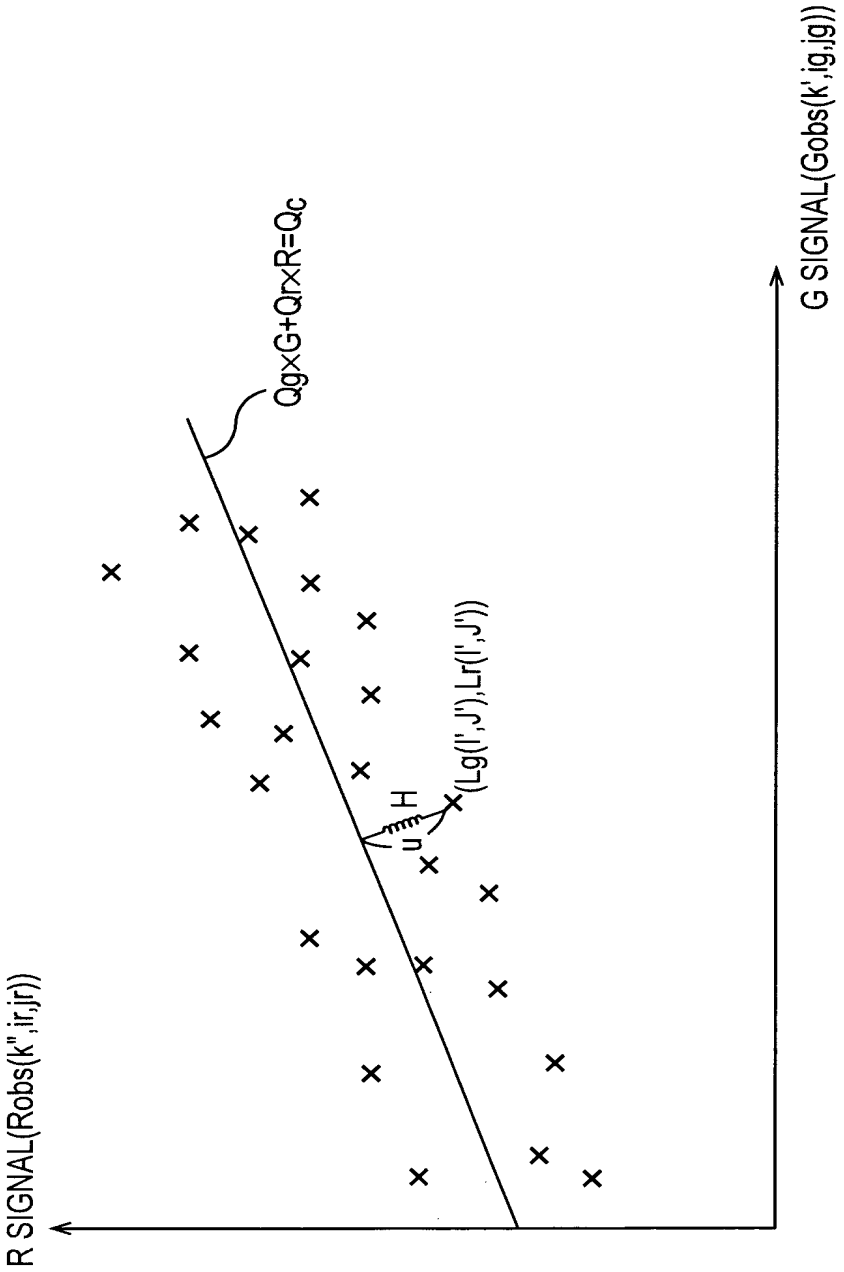
R SIGNAL(Robs(k'',ir,jr))
G SIGNAL(Gobs(k',ig,jg))
Qgx G+Qrx R=Qc
(Lg(I',J'),Lr(I',J'))
u
H

FIG. 39

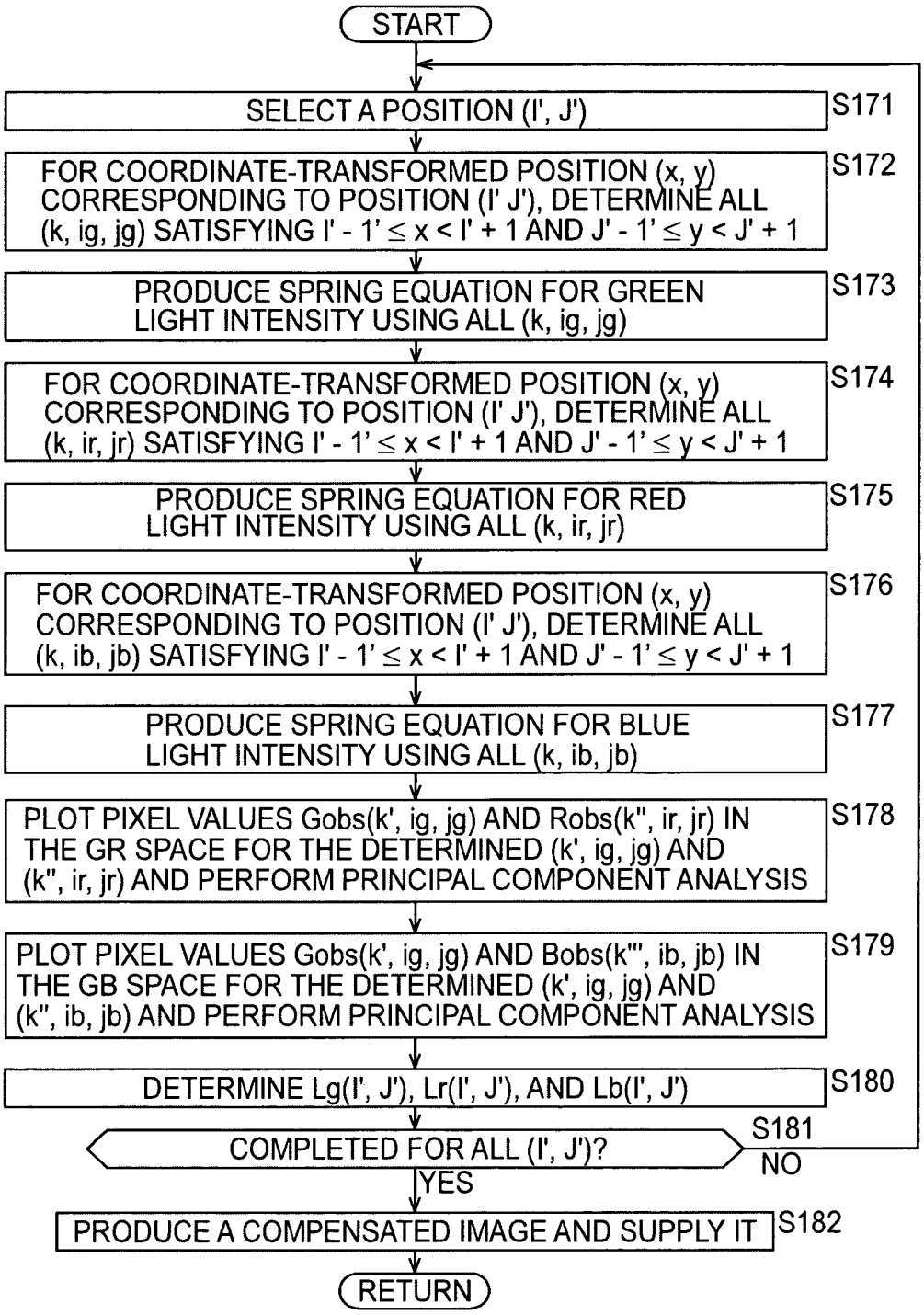
START
SELECT A POSITION (I', J')
S171
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ig, jg) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S172
PRODUCE SPRING EQUATION FOR GREEN LIGHT INTENSITY USING ALL (k, ig, jg)
S173
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ir, jr) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S174
PRODUCE SPRING EQUATION FOR RED LIGHT INTENSITY USING ALL (k, ir, jr)
S175
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO POSITION (I' J'), DETERMINE ALL (k, ib, jb) SATISFYING I' - 1' ≤ x < I' + 1 AND J' - 1' ≤ y < J' + 1
S176
PRODUCE SPRING EQUATION FOR BLUE LIGHT INTENSITY USING ALL (k, ib, jb)
S177
PLOT PIXEL VALUES Gobs(k', ig, jg) AND Robs(k", ir, jr) IN THE GR SPACE FOR THE DETERMINED (k', ig, jg) AND (k", ir, jr) AND PERFORM PRINCIPAL COMPONENT ANALYSIS
S178
PLOT PIXEL VALUES Gobs(k', ig, jg) AND Bobs(k"', ib, jb) IN THE GB SPACE FOR THE DETERMINED (k', ig, jg) AND (k", ib, jb) AND PERFORM PRINCIPAL COMPONENT ANALYSIS
S179
DETERMINE Lg(I', J'), Lr(I', J'), AND Lb(I', J')
S180
COMPLETED FOR ALL (I', J')?
S181
NO
YES
PRODUCE A COMPENSATED IMAGE AND SUPPLY IT
S182
RETURN

FIG. 40

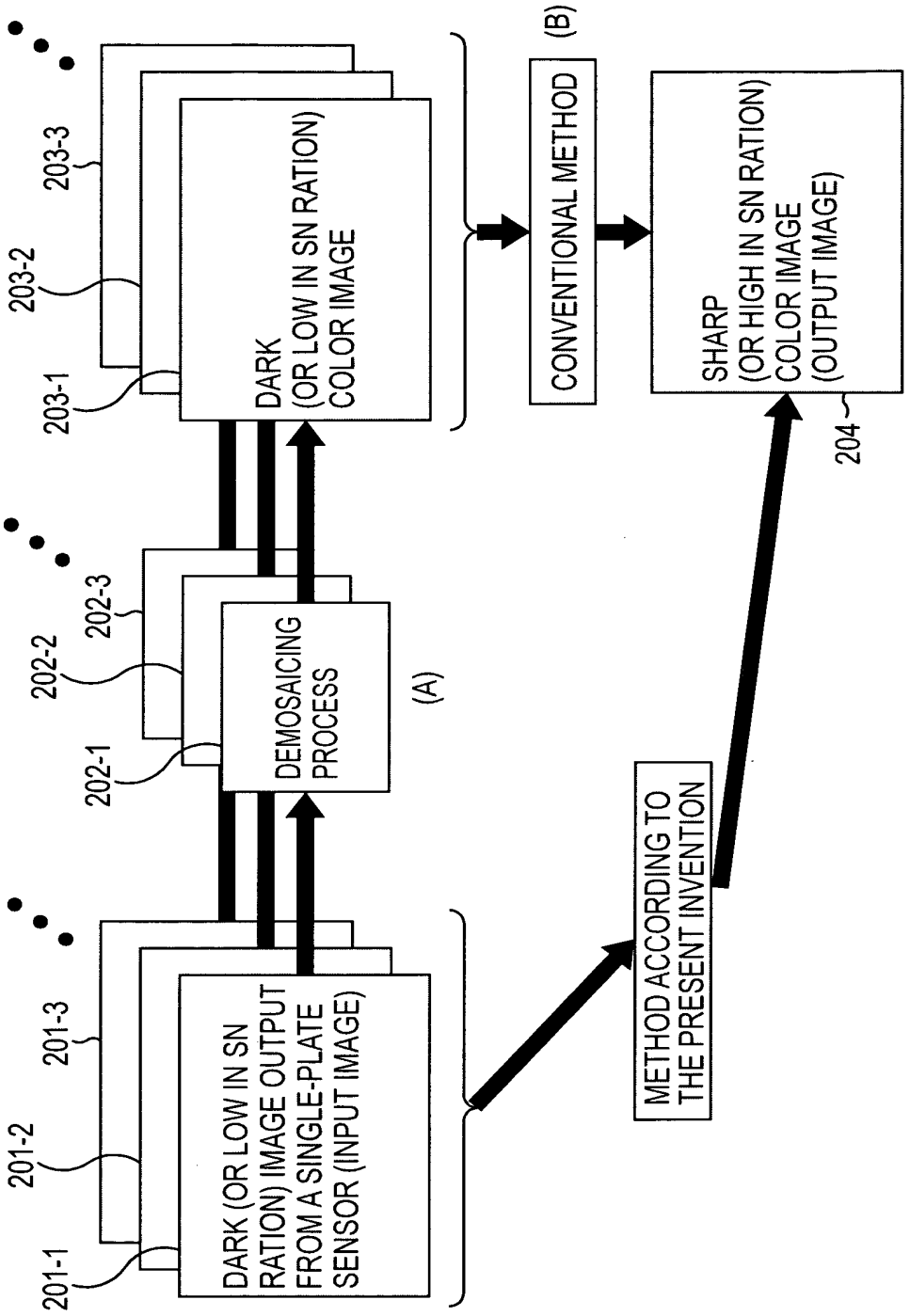
DARK (OR LOW IN SN RATION) IMAGE OUTPUT FROM A SINGLE-PLATE SENSOR (INPUT IMAGE)
201-1
201-2
201-3
DEMOSAICING PROCESS
202-1
202-2
202-3
(A)
DARK (OR LOW IN SN RATION) COLOR IMAGE
203-1
203-2
203-3
CONVENTIONAL METHOD
(B)
METHOD ACCORDING TO THE PRESENT INVENTION
SHARP (OR HIGH IN SN RATION) COLOR IMAGE (OUTPUT IMAGE)
204

FIG. 41

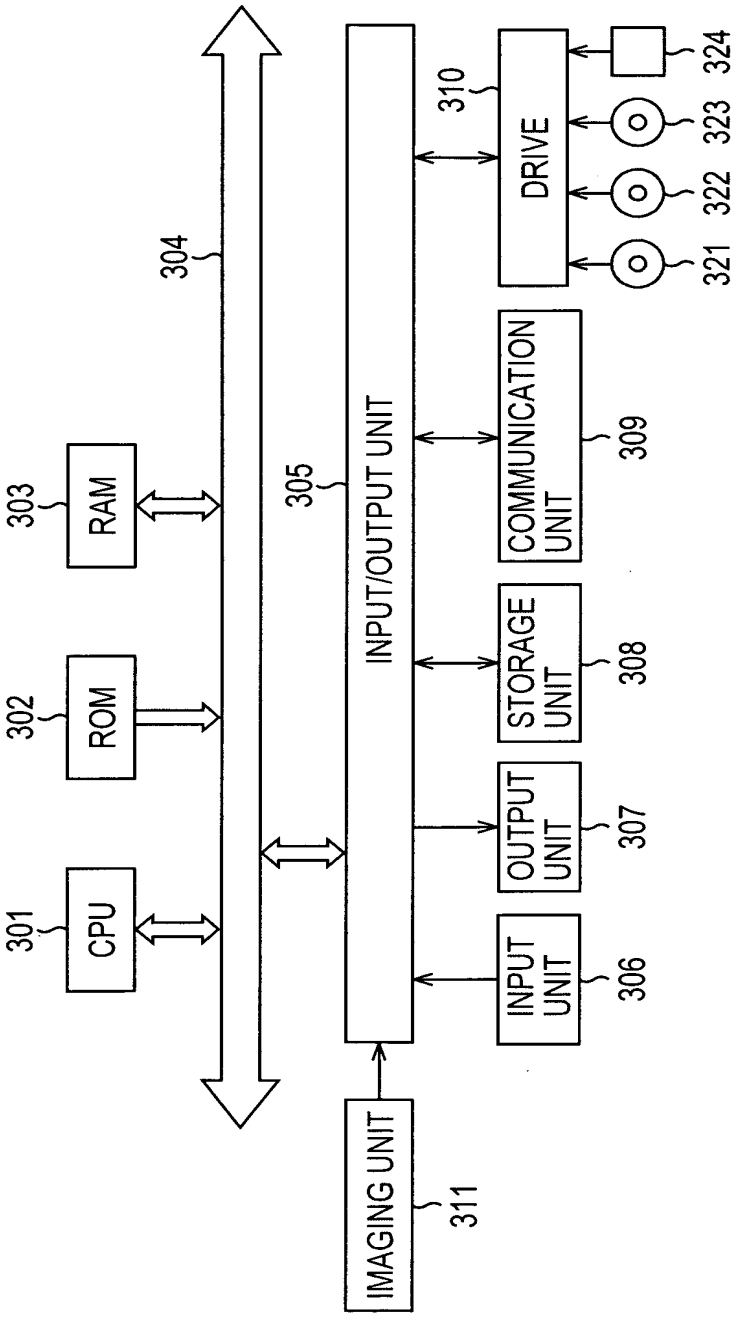
301
CPU
302
ROM
303
RAM
304
305
INPUT/OUTPUT UNIT
306
INPUT UNIT
307
OUTPUT UNIT
308
STORAGE UNIT
309
COMMUNICATION UNIT
310
DRIVE
311
IMAGING UNIT
321
322
323
324

FIG. 42

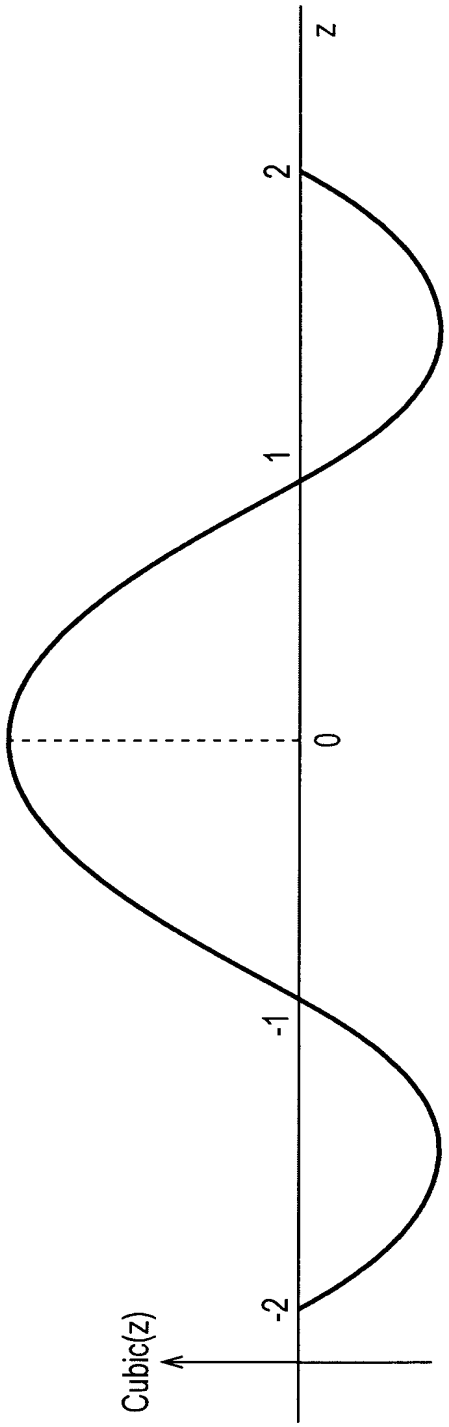

FIG. 43

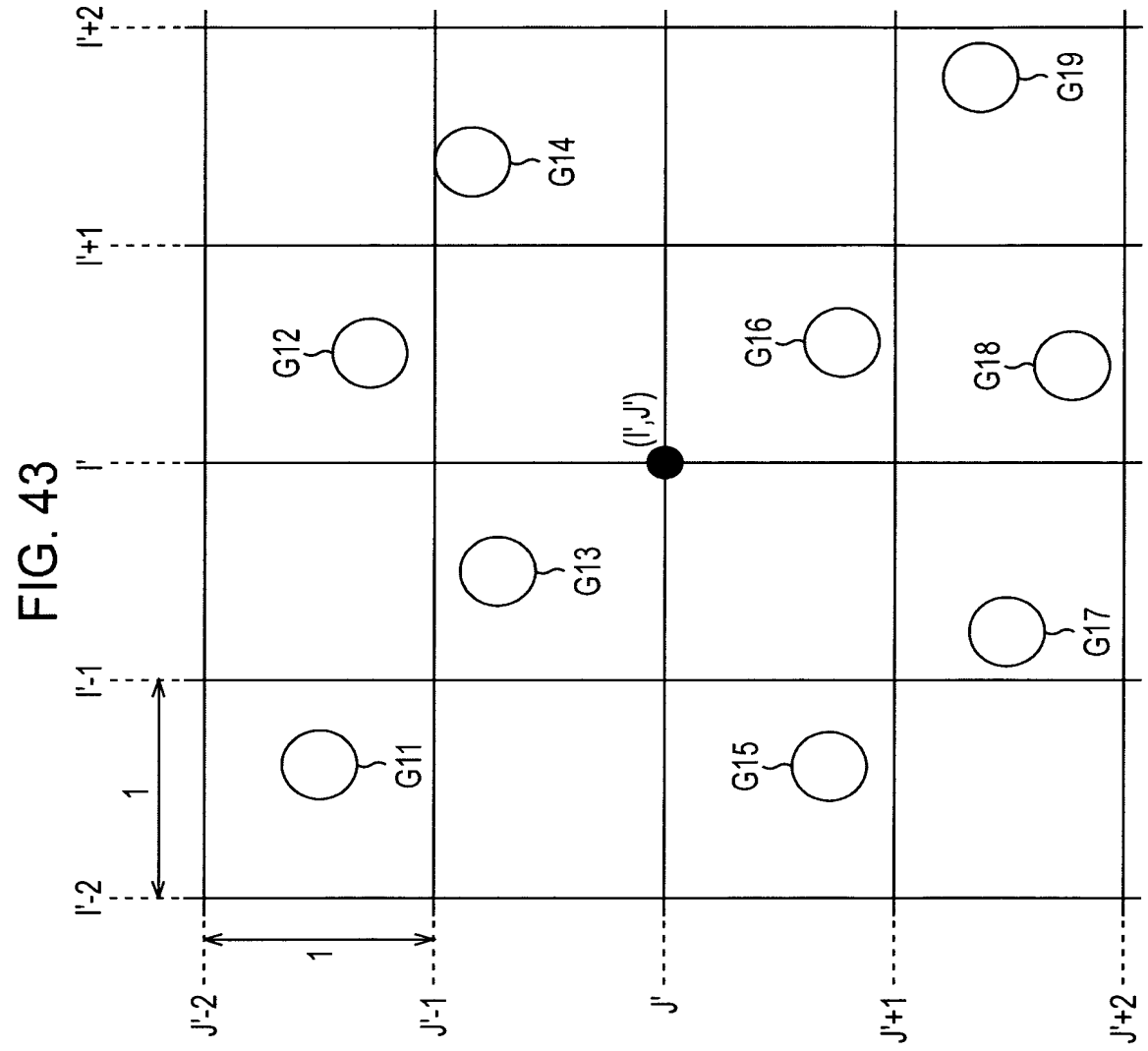

FIG. 44

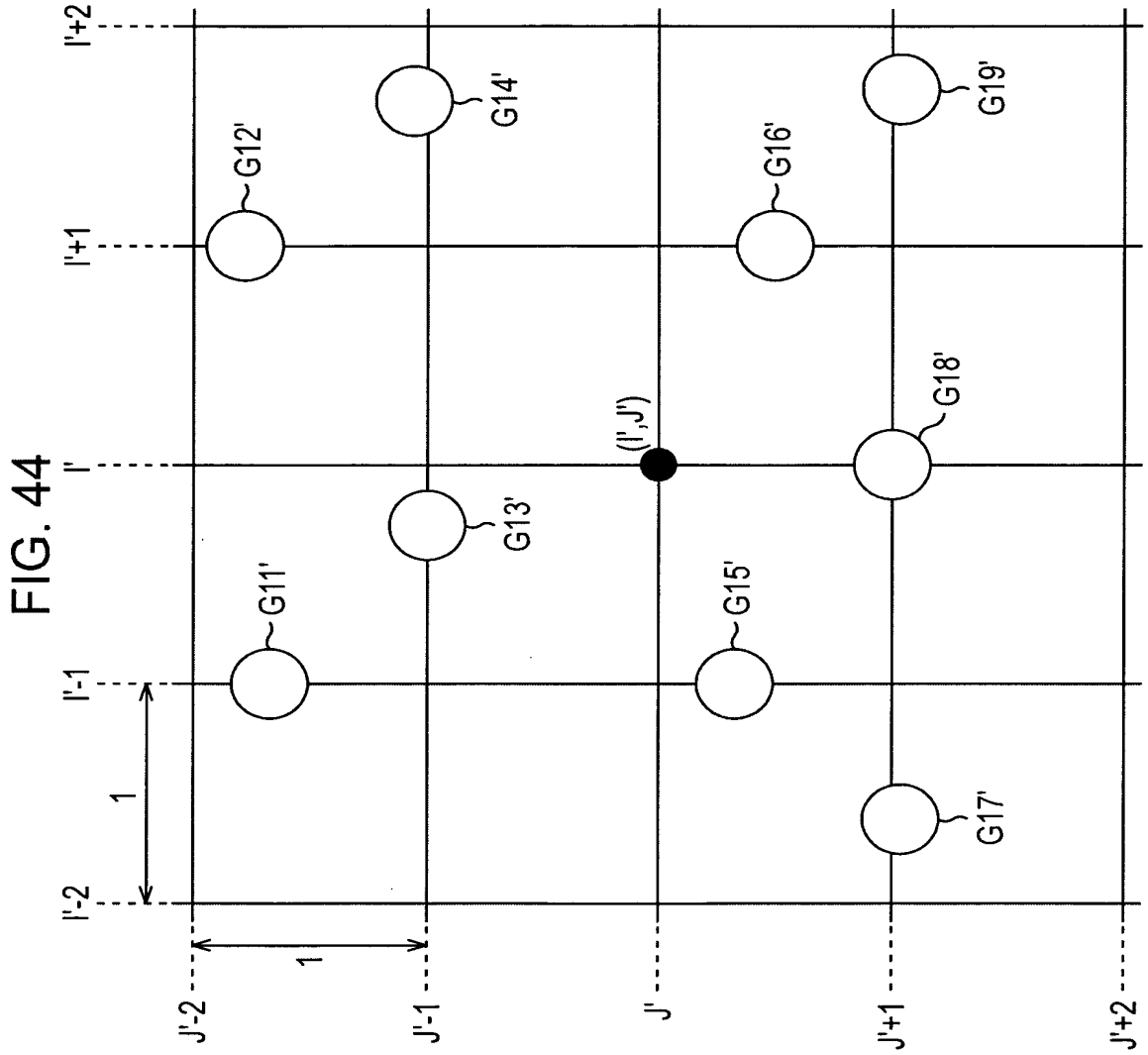

FIG. 45

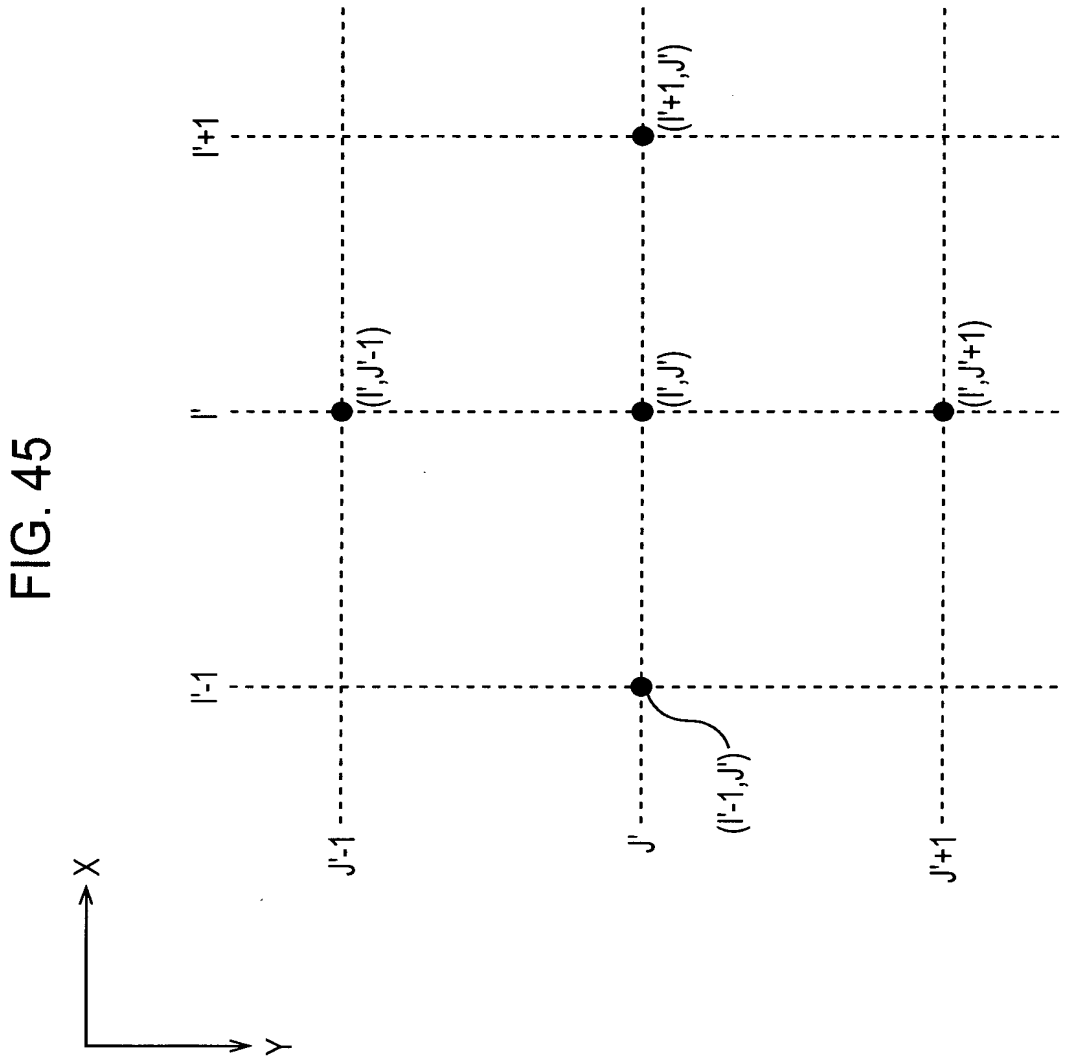

FIG. 46

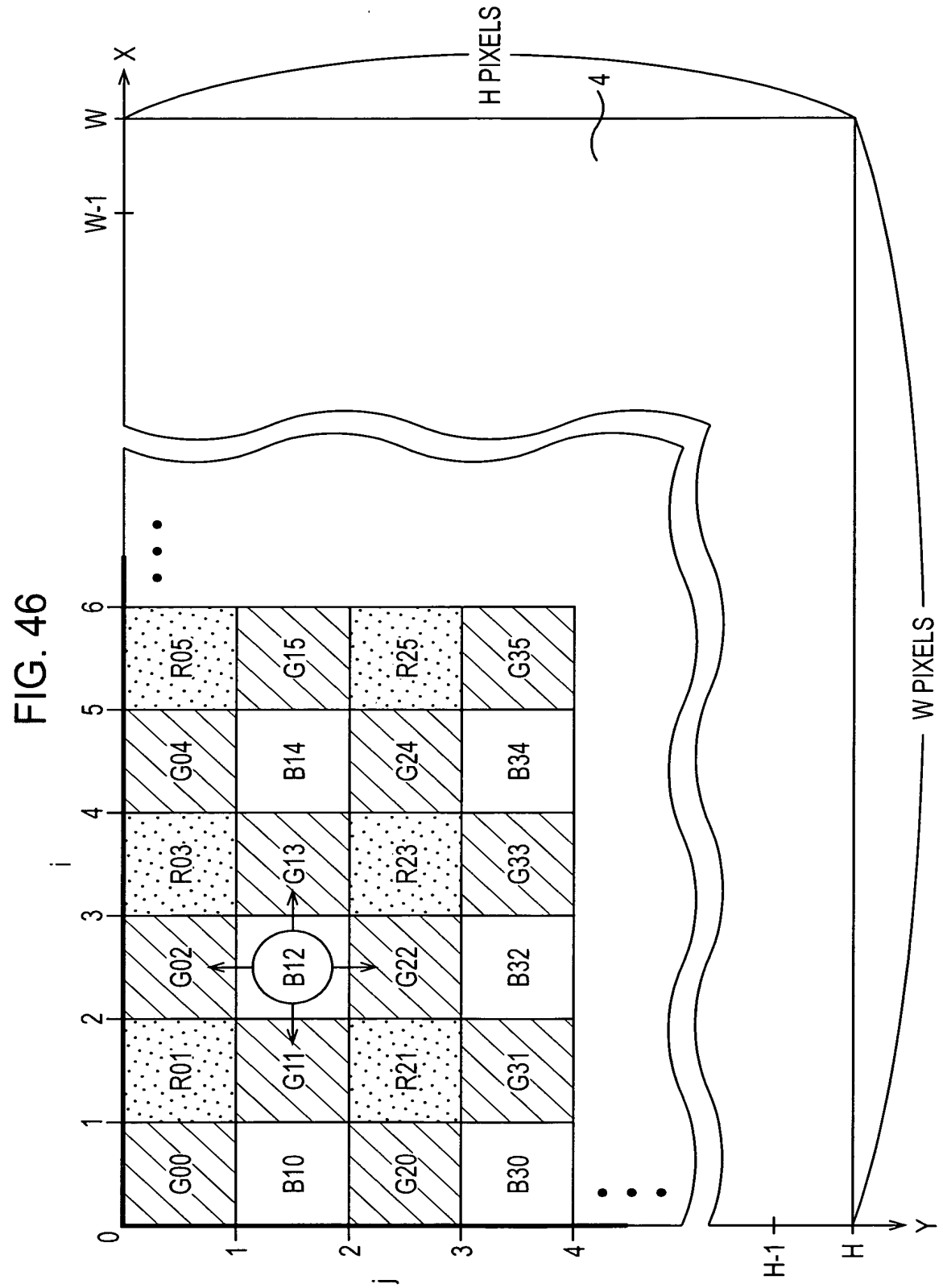
H PIXELS
4
X
W
W-1
W PIXELS
Y
H
H-1
i
j
0
1
2
3
4
5
6
G00
B10
R01
G11
G02
B12
R03
G13
G04
B14
R05
G15
G20
B30
R21
G31
G22
B32
R23
G33
G24
B34
R25
G35

FIG. 47

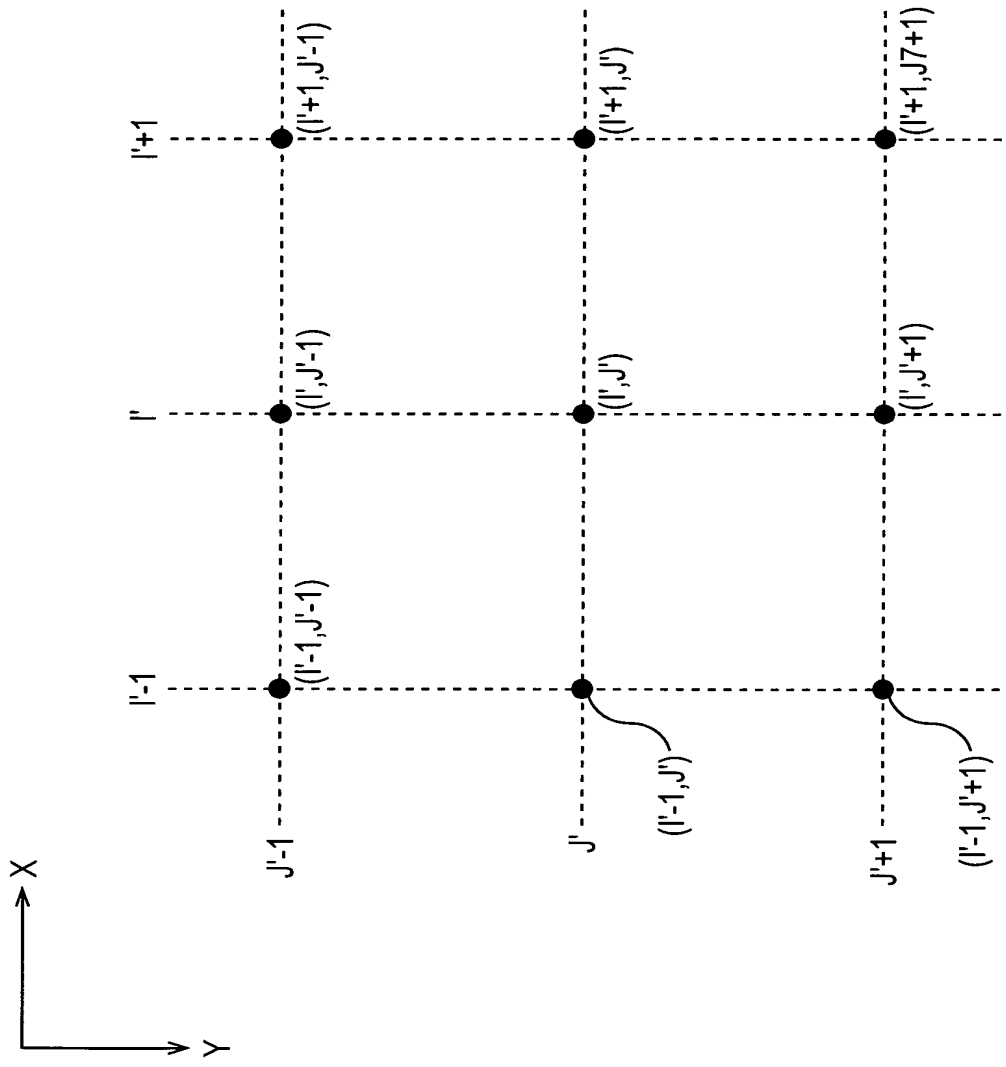

FIG. 48

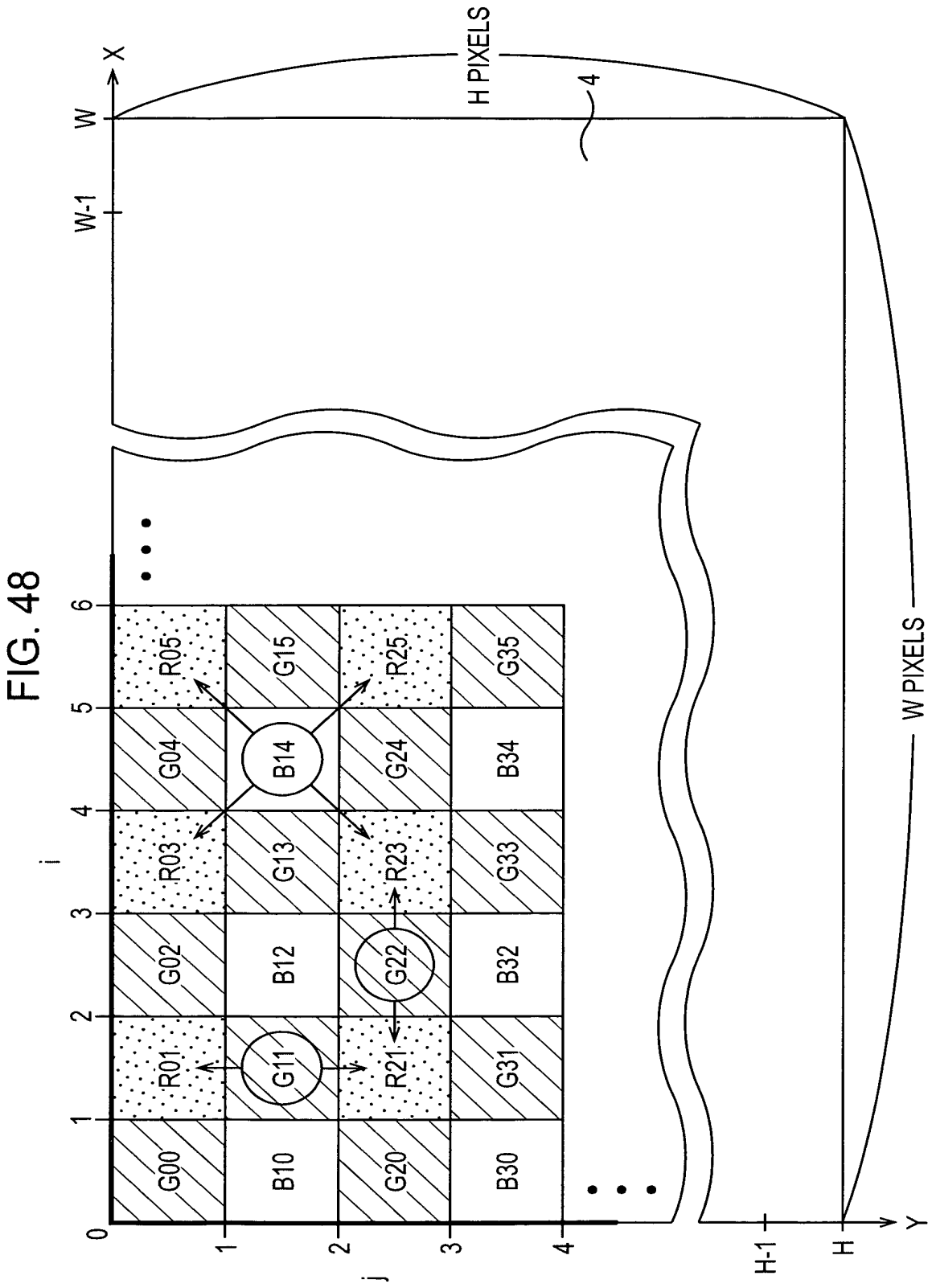
H PIXELS
4
X
W
W-1
W PIXELS
Y
H-1
H
i
j
0
1
2
3
4
5
6
G00
B10
G20
B30
R01
G11
R21
G31
G02
B12
G22
B32
R03
G13
R23
G33
G04
B14
G24
B34
R05
G15
R25
G35

FIG. 49

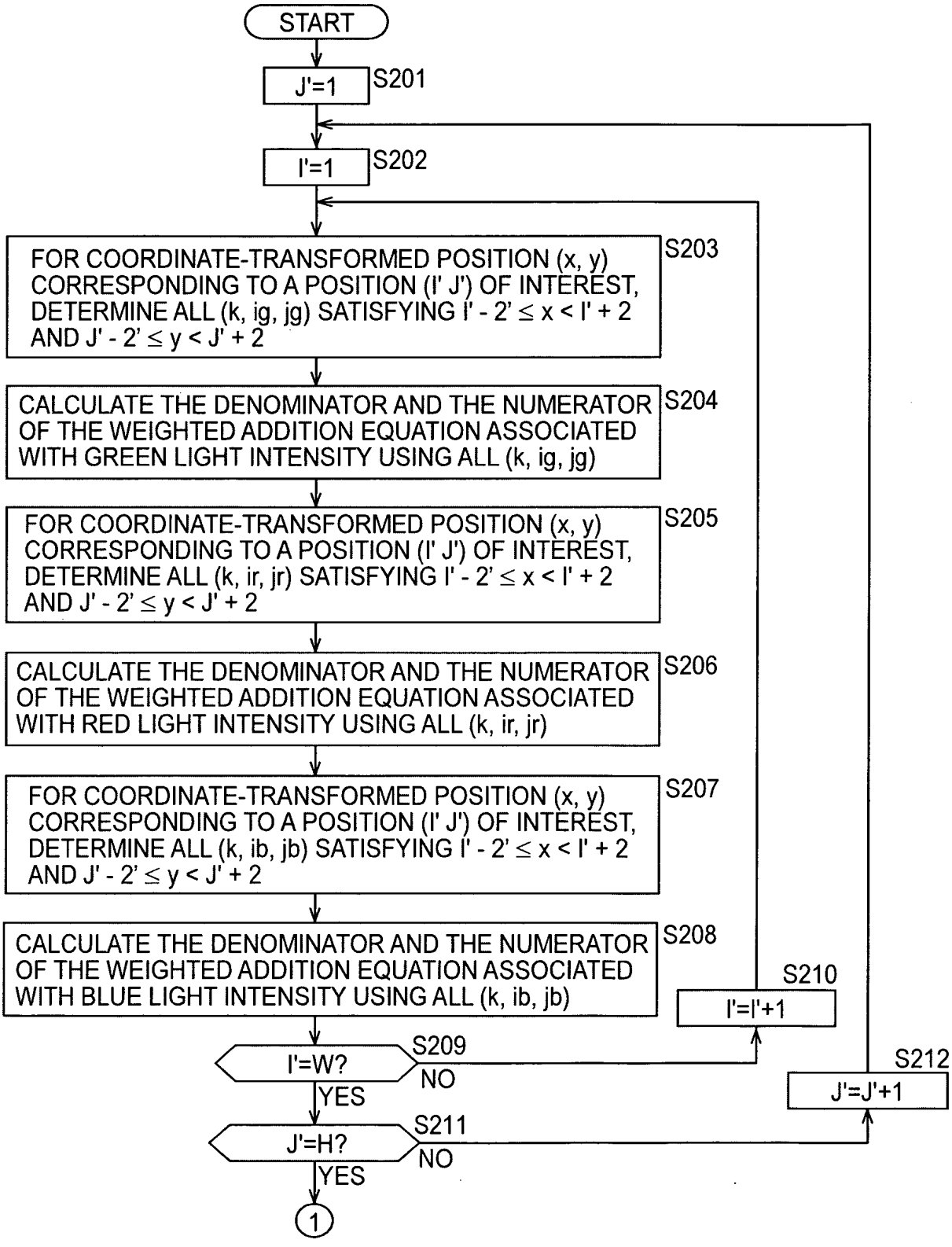
START
J'=1
S201
I'=1
S202
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO A POSITION (I' J') OF INTEREST, DETERMINE ALL (k, ig, jg) SATISFYING I' - 2' ≤ x < I' + 2 AND J' - 2' ≤ y < J' + 2
S203
CALCULATE THE DENOMINATOR AND THE NUMERATOR OF THE WEIGHTED ADDITION EQUATION ASSOCIATED WITH GREEN LIGHT INTENSITY USING ALL (k, ig, jg)
S204
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO A POSITION (I' J') OF INTEREST, DETERMINE ALL (k, ir, jr) SATISFYING I' - 2' ≤ x < I' + 2 AND J' - 2' ≤ y < J' + 2
S205
CALCULATE THE DENOMINATOR AND THE NUMERATOR OF THE WEIGHTED ADDITION EQUATION ASSOCIATED WITH RED LIGHT INTENSITY USING ALL (k, ir, jr)
S206
FOR COORDINATE-TRANSFORMED POSITION (x, y) CORRESPONDING TO A POSITION (I' J') OF INTEREST, DETERMINE ALL (k, ib, jb) SATISFYING I' - 2' ≤ x < I' + 2 AND J' - 2' ≤ y < J' + 2
S207
CALCULATE THE DENOMINATOR AND THE NUMERATOR OF THE WEIGHTED ADDITION EQUATION ASSOCIATED WITH BLUE LIGHT INTENSITY USING ALL (k, ib, jb)
S208
I'=W?
S209
NO
YES
I'=I'+1
S210
J'=H?
S211
NO
YES
J'=J'+1
S212
1

FIG. 50

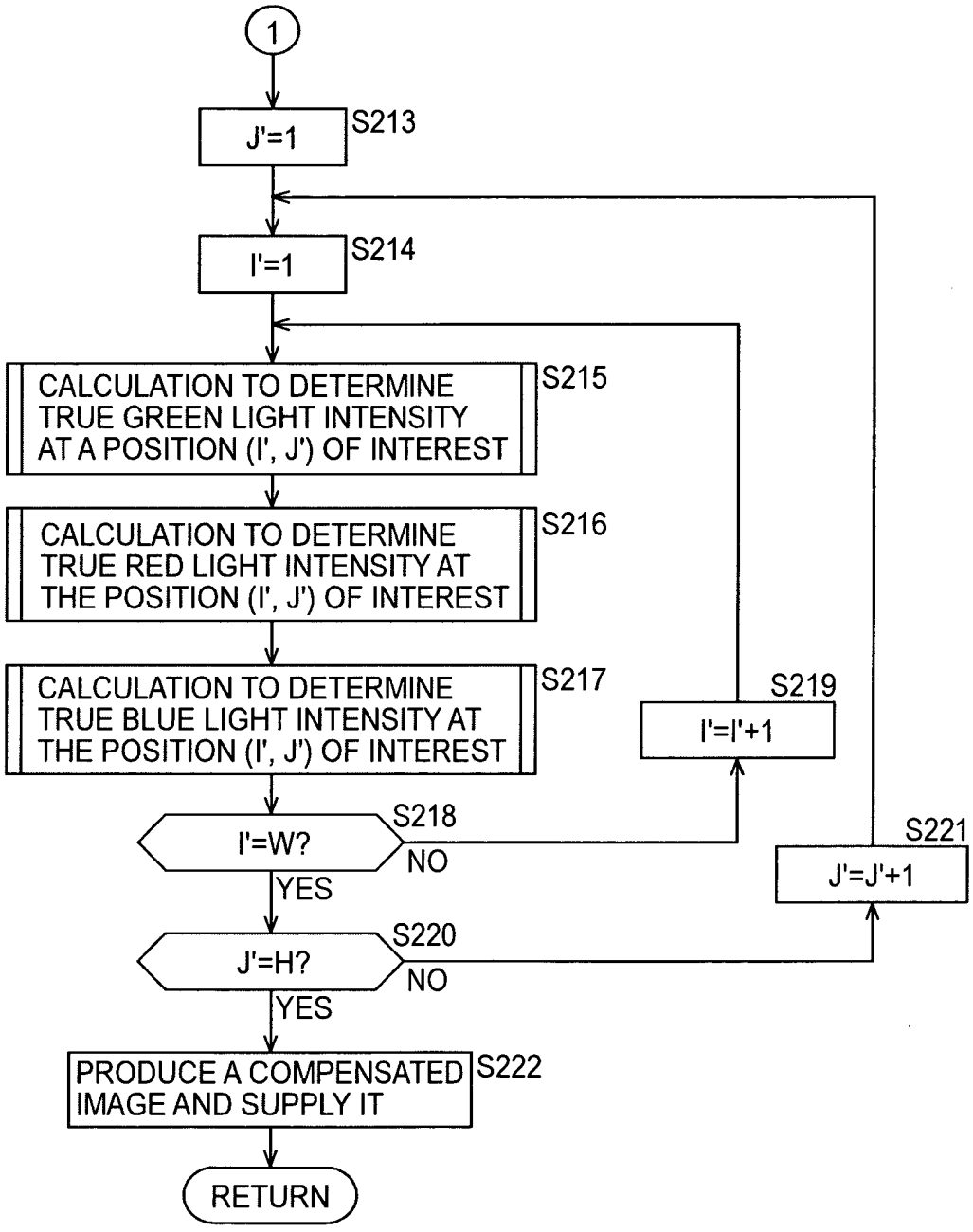
1
J'=1
S213
I'=1
S214
CALCULATION TO DETERMINE TRUE GREEN LIGHT INTENSITY AT A POSITION (I', J') OF INTEREST
S215
CALCULATION TO DETERMINE TRUE RED LIGHT INTENSITY AT THE POSITION (I', J') OF INTEREST
S216
CALCULATION TO DETERMINE TRUE BLUE LIGHT INTENSITY AT THE POSITION (I', J') OF INTEREST
S217
I'=I'+1
S219
I'=W?
S218
NO
YES
J'=J'+1
S221
J'=H?
S220
NO
YES
PRODUCE A COMPENSATED IMAGE AND SUPPLY IT
S222
RETURN

FIG. 51

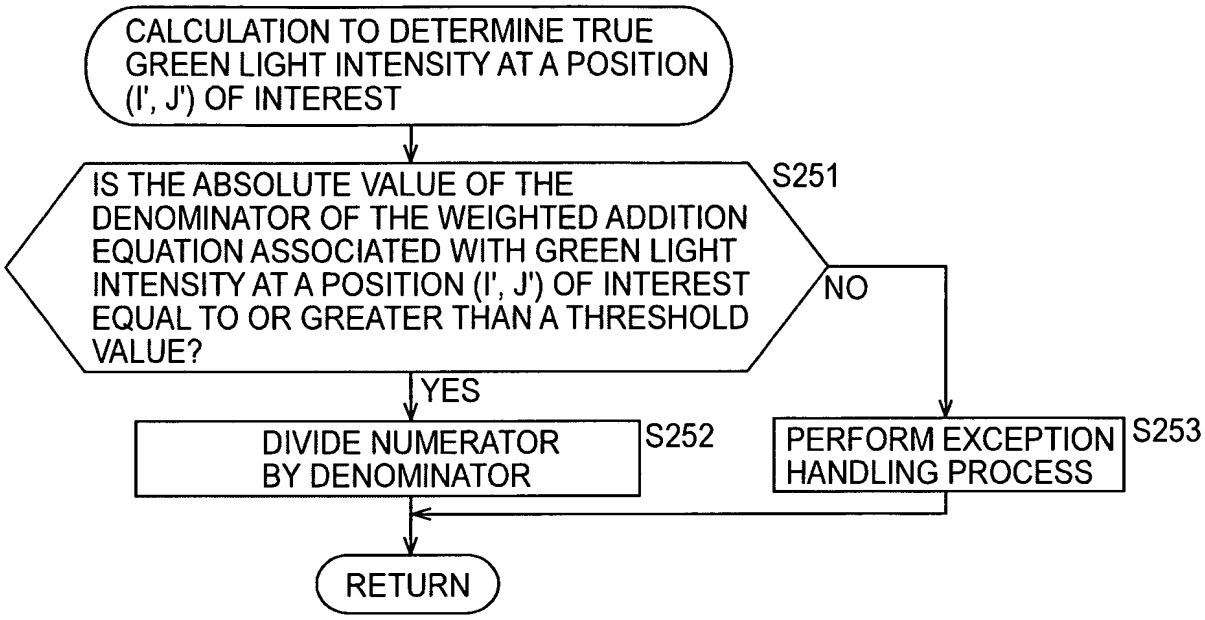
CALCULATION TO DETERMINE TRUE GREEN LIGHT INTENSITY AT A POSITION (I', J') OF INTEREST
IS THE ABSOLUTE VALUE OF THE DENOMINATOR OF THE WEIGHTED ADDITION EQUATION ASSOCIATED WITH GREEN LIGHT INTENSITY AT A POSITION (I', J') OF INTEREST EQUAL TO OR GREATER THAN A THRESHOLD VALUE?
S251
NO
YES
DIVIDE NUMERATOR BY DENOMINATOR
S252
PERFORM EXCEPTION HANDLING PROCESS
S253
RETURN

FIG. 52

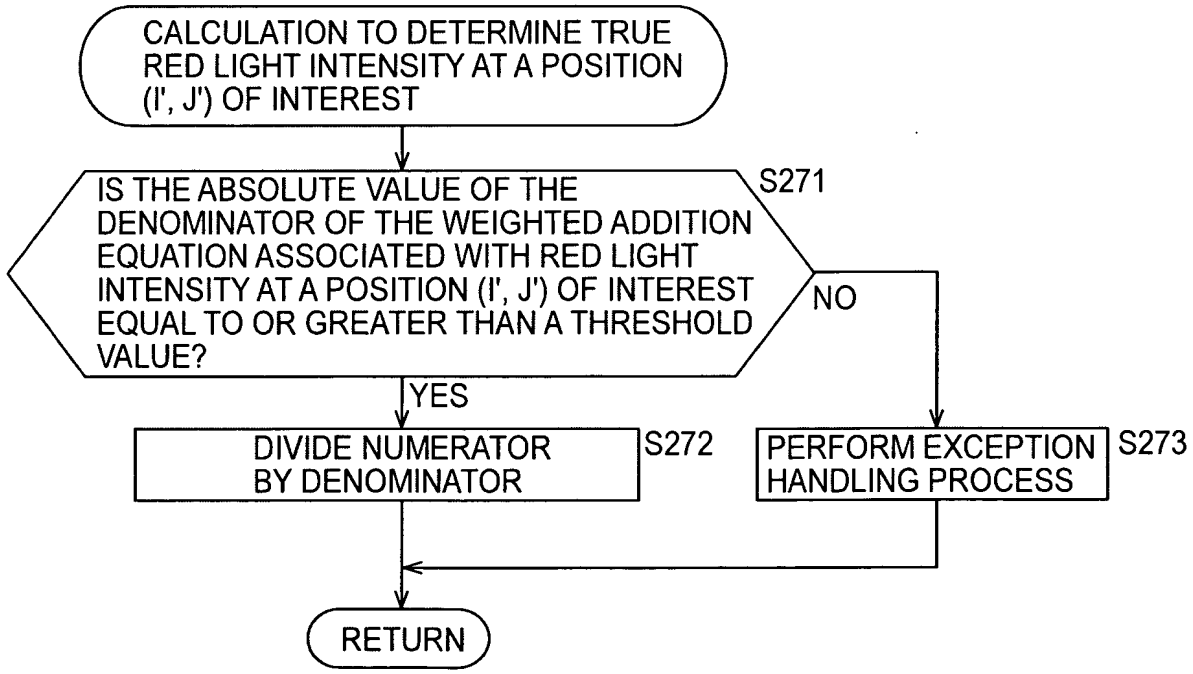
CALCULATION TO DETERMINE TRUE RED LIGHT INTENSITY AT A POSITION (I', J') OF INTEREST
IS THE ABSOLUTE VALUE OF THE DENOMINATOR OF THE WEIGHTED ADDITION EQUATION ASSOCIATED WITH RED LIGHT INTENSITY AT A POSITION (I', J') OF INTEREST EQUAL TO OR GREATER THAN A THRESHOLD VALUE?
S271
NO
YES
DIVIDE NUMERATOR BY DENOMINATOR
S272
PERFORM EXCEPTION HANDLING PROCESS
S273
RETURN

FIG. 53

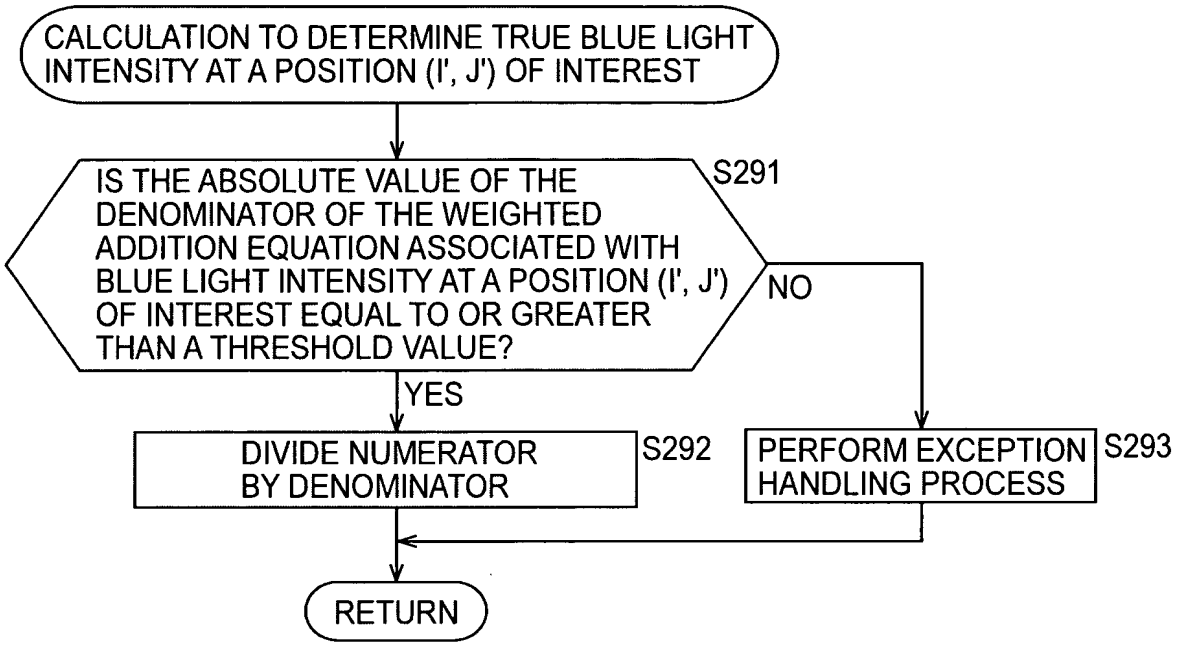
CALCULATION TO DETERMINE TRUE BLUE LIGHT INTENSITY AT A POSITION (I', J') OF INTEREST
IS THE ABSOLUTE VALUE OF THE DENOMINATOR OF THE WEIGHTED ADDITION EQUATION ASSOCIATED WITH BLUE LIGHT INTENSITY AT A POSITION (I', J') OF INTEREST EQUAL TO OR GREATER THAN A THRESHOLD VALUE?
S291
NO
YES
DIVIDE NUMERATOR BY DENOMINATOR
S292
PERFORM EXCEPTION HANDLING PROCESS
S293
RETURN

FIG. 54

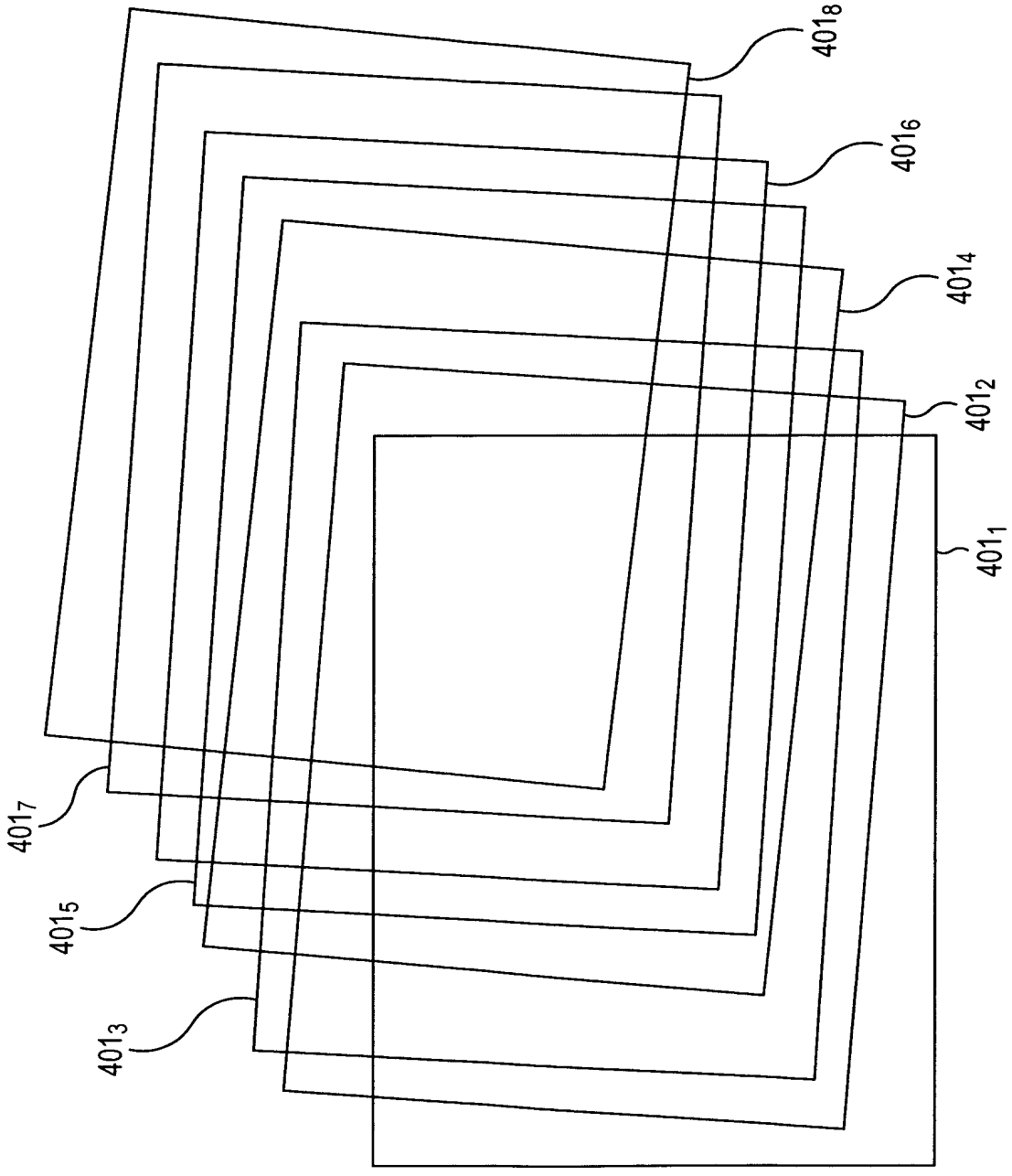

FIG. 55

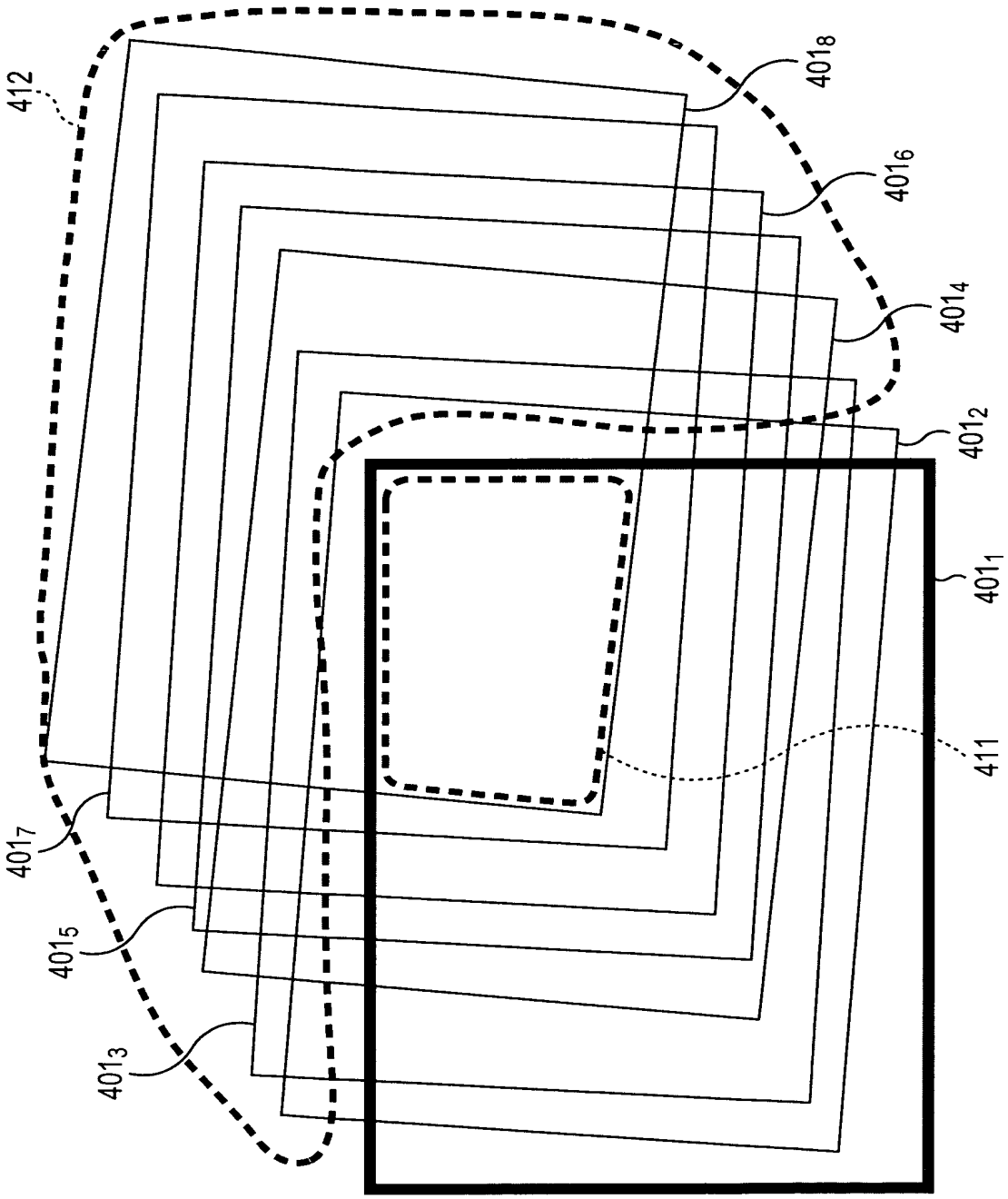
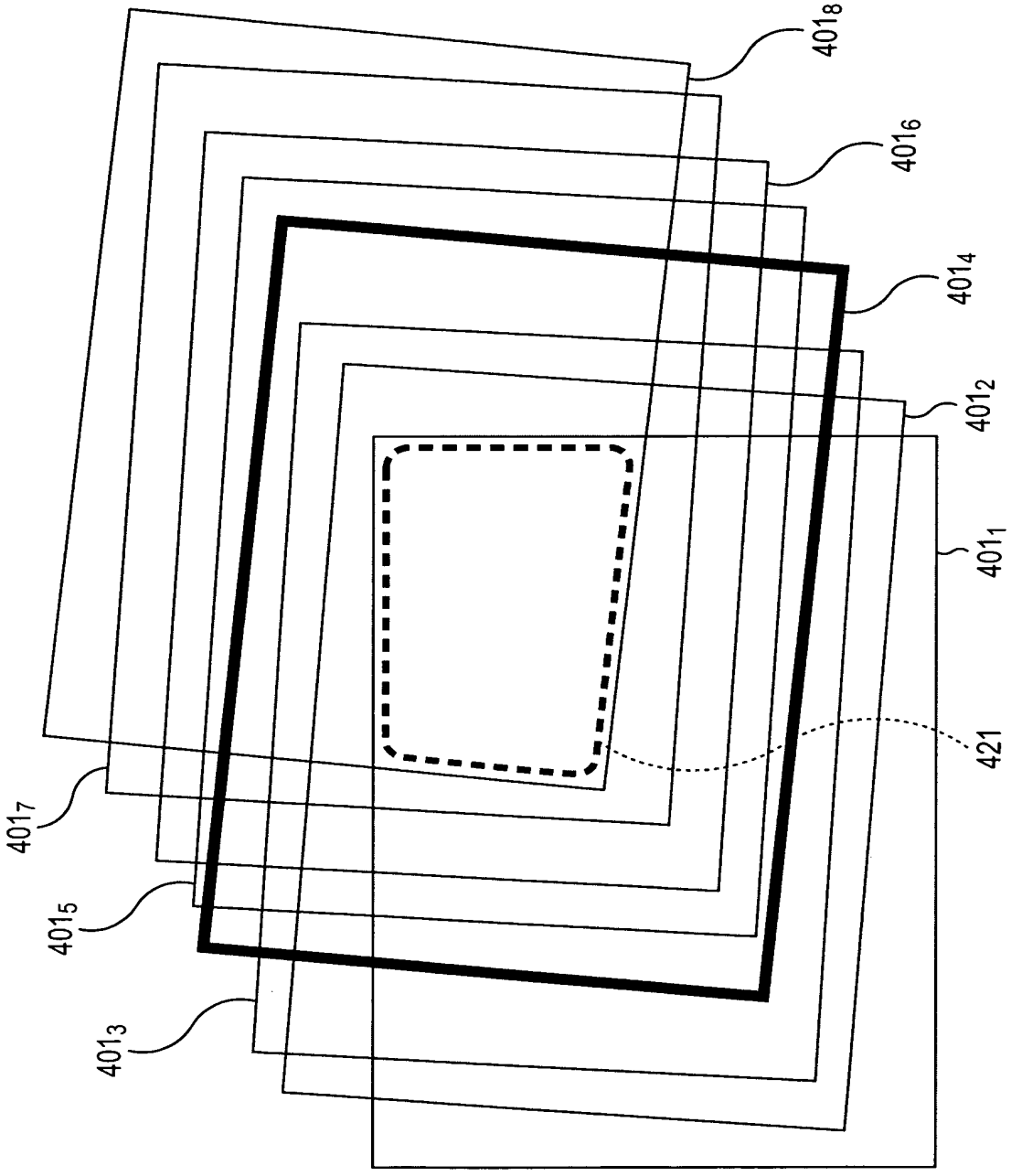
FIG. 56